Sector-Based Public Policy in the Asia-Pacific Region:

Planning, Regulating, and Innovating for Sustainability

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United States–Asia Environmental Partnership

Launched as a presidential initiative in 1992, US-AEP is a public-private, interagency program led by USAID. US-AEP promotes environmentally sound economic growth in Asia by mobilizing American technologies, services, and experience. US-AEP's goal is to promote a "clean revolution" in Asia—the development and adoption of less polluting and more resource-efficient products, processes, and services. The partnership includes the U.S. Department of Commerce, the U.S. Environmental Protection Agency, nongovernmental organizations, environmental technology associations, grant-making bodies, and private contractors responsible for the following US-AEP programs: the Environmental Exchange Program, Clean Technology and Environmental Management, Technology Transfer, and The Policy Group.

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[October 1999]

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ACRONYMS

BOI	Philippine Board of Investments
CSI	Common Sense Initiative
EHS	Environment, health, and safety
EPU	Economic Planning Unit
Fab	Semiconductor (wafer) fabrication facility
GDP	Gross domestic product
GIN-Asia	Greening of Industry Network–Asia
HKPC	Hong Kong Productivity Council
ISO	International Standards Organization
ITRI	Industrial Technology Research Institute (Taiwan)
NGO	Nongovernmental organization
ODS	Ozone-depleting substances
PCB	Printed circuit board
PFC	Perfluorocompound
PWB	Printed wiring board
R&D	Research and development
SAR	Special Administrative Region
SME	Small and medium enterprise
Taiwan EPA	Taiwan Environmental Protection Administration
US-AEP	United States–Asia Environmental Partnership
USAID	U.S. Agency for International Development
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound
XL	Excellence and Leadership (Project XL)

MAP OF THE ASIA-PACIFIC REGION

ACKNOWLEDGEMENTS

The United States–Asia Environmental Partnership (US-AEP) and Greening of Industry Network–Asia (GIN-Asia) bear a special debt of gratitude to the following individuals and entities: the U.S. Agency for International Development (USAID) for its support of this publication; Charles Freeman and Doris Ma at The Asia Foundation (Hong Kong) and Pauline Lau at the Hong Kong-American Center for facilitating conference logistics; and the Chinese University of Hong Kong for its warm hospitality.

In addition, the authors would like to thank the following people from the US-AEP and USAID family for their generous contributions of time, support, and assistance: Karla Boreri, Salina Chan, Sandy Chan, Jennifer Crawford, Emma Escover, Keith Gilges, Vivian How, Sarita Hoyt, Jennifer Huang, Nao Ikemoto, Chan Yiu Kei, Kitti Kumpeera, Chi-Sun Lee, Albert Leung, Lisa Kircher Lumbao, Ted MacDonald, Scott Phillips, Satit Sanongphan, Dinah Tsen, and David Wagner.

Brenda Ortigoza Bateman coordinated this project, synthesizing and editing input from the following workshop participants: Wendy Aritenang, Gil Bergquist, Richard Chan, Hung Min Chein, Owen Cylke, Victor Leong, C. M. Lin, Yusran Munaf, Greg Ondich, S. Pubalan, Pola Singh, Lynda Vicars, Florina Vistal, and Mary Jo Waits. See appendix B for additional biographical information.

Special thanks to Scott Bartos with the U.S. Environmental Protection Agency's Office of Air and Radiation Climate Protection Division for providing input and review of the draft publication.

FOREWORD

In August 1999, thirteen senior development planners and environmental experts from the Asia-Pacific region met with colleagues from US-AEP and GIN-Asia at a workshop held in Hong Kong Special Administrative Region (SAR). Focusing on the electronics industry as a common reference point, participants discussed the feasibility of using public policies organized by industry sector to help direct state and national movement toward sustainable development. Public policymakers continue to follow a mandate to pursue industrial development in the midst and in the wake of a regional economic crisis. It is imperative that environmental protection not be overshadowed by industrial growth.

The group included participants from Hong Kong, Indonesia, Malaysia, the Philippines, Taiwan, Thailand, and the United States. During the three-day discussion, participants provided a brief update of industry sector–based programs under their purview and predictions or recommendations for policymakers who might want to consider using this approach.

The workshop produced a core group interested in working together to develop a regionwide public policy model that would constitute a framework for this report. *Sector-Based Public Policy in the Asia-Pacific Region* evolved out of that workshop and is a companion piece to US-AEP's April 1999 publication, *Place-Based Public Policy in Southeast Asia*. This report was prepared for US-AEP and its colleagues, including GIN-Asia's Eighth International Conference at the University of North Carolina (Chapel Hill), November 14–17, 1999.

Brenda Ortigoza Bateman
US-AEP
October 1, 1999

CHAPTER 1:

WHAT IS SECTOR-BASED PUBLIC POLICY?

Economic indicators across the Asia-Pacific region predict the beginning of recovery for countries facing economic crisis in the past two years. With stock markets on the upswing and a return to positive growth in gross domestic product (GDP),[1] Greater China (China, Hong Kong, and Taiwan), Southeast Asia (Indonesia, Malaysia, the Philippines, Singapore, and Thailand), and Northeast Asia (Japan and South Korea) are again looking to capture the fast-growing business and consumer markets promised five years ago as part of the Asian economic boom.

Some believe a return to rapid economic growth in the Asia-Pacific region will renew the threat of environmental meltdown. Assuming 8 percent industrial growth per year, in just 25 years, 80 percent of the industrial sector in Asia will consist of manufacturing plants not yet built. It is expected that more than 60 percent of world income will originate in Asia by 2025. It is the momentum of these forces that suggests that the world's environmental future will be determined in large measure by what happens in Asia. If concern for the environment is made part of economic reform, the prospects are bright. If not, the Asian rebound will be a problem for everyone.[2]

The *Far Eastern Economic Review,* however, optimistically believes that "economic growth has been a good thing for the environment. . . . as economies expand and labor costs rise, industries are forced either to become more efficient or perish, and as great efficiency also means less waste . . . factories evolve as economies grow more advanced."[3]

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1 Review Publishing Company (1999c).
2 Cylke (1999).
3 Review Publishing Company (1999b).

With this hopeful outlook in mind, policymakers in the Asia-Pacific region are verbalizing goals for what the international community calls "sustainable development," a process that "meets the needs of the present generation without compromising the ability of future generations to meet their own needs."[4] On closer inspection, this definition of sustainable development reflects a broader concern not only for economic development, but for the environment and other social issues as well, such as standards of living and working. In an era of limited resources—particularly at the government level—public policymakers in the Asia-Pacific region are pondering the most efficient ways to set priorities to begin to meet these goals.

The ability to bundle industrial environmental and development issues together into broad categories is one method of focusing limited government resources more efficiently. One can focus improved environmental performance requirements on different types of industrial facilities that require the most attention and can be bundled together, for example:

- "Most heavily polluting facilities" (typically very large companies)
- "Place-based" industrial groupings (for which economic activity is clustered within a geographic area, be it a tract of land, a city, a national boundary, or a region)
- Specific "industrial sectors"[5] (firms that produce the same end product, such as textiles, automobiles, or electronics).

With the caveat that "sector-based policy" geared toward the latter, that is, specific industries, is but one of several possible "organizing principles" available to policymakers, this report will analyze work already under way in this area and identify opportunities for further development.

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4 Brundtland Commission (1987).

5 In this publication, the term "industry sector" refers to firms that produce the same end product. In the United States, for example, a company is assigned a Standard Industrialization Code (SIC) according to its primary product. A sector-specific strategy focuses on a particular industry with no particular emphasis on any single geographical location.

Sector-Based Policy Approaches

The U.S. Environmental Protection Agency (USEPA) conducted some of the early sector-based programs and has explained the circumstances that prompted it to search out sector-based environmental solutions in the first place:

> Pollutant releases to each environmental medium (air, water, and land) affect each other, and so environmental strategies must actively identify and address these interrelationships by designing policies for the whole facility. One way to achieve a whole facility focus is to design environmental policies for similar industrial facilities. By doing so, environmental concerns that are common to the manufacturing of similar products can be addressed in a comprehensive manner.[6]

Sector-based programs are quite diverse. Loosely grouped into two categories, they include *(a)* core regulatory functions (industry-specific effluent guidelines, multimedia [air, waste, water, and so on] permitting, industry enforcement and compliance) and *(b)* industrial planning. These two categories are the subjects of chapters two and three, respectively.

Policymakers believe that sector-based approaches can provide several benefits:

At the outset, they identify a discrete pool of facilities or representative facilities with whose representatives government officials can meet and dialogue. This group of facilities can provide comprehensive information about how regulation of that industry sector could affect businesses and how the sector could become more efficient. The group can also serve as an "early warning system" that identifies barriers and incentives that might affect implementation of a regulation or other programs. In addition, the group can help set more realistic industrial environmental goals.

Sector-based planning, thus, can create the framework for reducing regulatory burdens and, ultimately, for deregulating in

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[6] USEPA (1995a).

favor of developing performance-based environmental protection strategies. Simply put, sector-based planning can serve as a bridge for transforming regulatory systems into more efficient environmental protection systems, both financially and administratively, and as a catalyst to shift from contentious, litigious systems to more cooperative partnerships.

Sector-based planning is a leveraging strategy that can substantially increase the financial, scientific, and human resources applied to solving environmental problems. This, in turn, may free up some time and resources, encouraging behavior beyond compliance and addressing environmental problems that as yet lack regulatory solutions. Sector-based planning also has the potential to generate much higher levels of environmental benefits, resulting from the greater flexibility given to industries to improve their environmental performance creatively. Industries that are responsible for achieving their own environmental results are likely to develop more effective, financially efficient, and, therefore, more successful technologies. Industry officials find that with sector-based planning they have more options in the management toolbox—technology partnerships, pollution prevention, and product stewardship, for example.

Next, sector-based planning allows room for other stakeholders to become involved, stay informed, and provide feedback. This results in greater corporate accountability to interested groups such as workers and neighborhood communities. Better quality information is developed throughout this process, which means all involved parties have an opportunity to increase communication and trust. The process also increases stakeholder "ownership" of the decisions made. Industry groups are, therefore, more likely to internalize environmental protection as an ongoing part of their business ethic and operations.

Sector-based environmental planning and management is an emerging concept in Asia with no fully developed examples of how its implementation can achieve environmental results. For that, one must turn to a sector-based environmental system already in place in another part of the world that is operating suc-

cessfully at multiple levels of government, industry, and civil society. The Netherlands provides one such example.

The Dutch Covenant System

The Netherlands has assembled a full array of sector-based approaches into a national package that serves as a powerful model for environmental improvement and protection.

The National Environmental Policy Plans of the Netherlands set out a strategy for achieving sustainable development within the next generation. The strategy includes establishing national environmental objectives, measuring progress toward those goals, identifying and working with target groups of stakeholders who are economically and environmentally positioned to accomplish such goals, and devolving much of the responsibility for improvement to groups in society other than government.

The reason this approach is considered "sector based" is because it identifies from the outset the source (or potential source) of environmental problems, making clear which industry sector is responsible for preventative and cleanup action. It also enables the "source" to deal with a possible chain of effects and to reduce the risk of creating irreversible effects. The Dutch government has identified ten industry sectors that account for 80 percent of the country's industrial pollution. Since 1990 the Government of the Netherlands has negotiated more than a dozen industry covenants in all.

Companies in those industries have made a commitment to do their part to meet national environmental objectives by signing individual agreements based on these covenants that are binding under civil law for four years. When regulations already exist on specific environmental topics, the covenants serve as a specific implementation road map. When regulations do not exist, the covenants provide a framework for improvement. Activities under each covenant can include creation of the industry's environmental profile, an industry sector environmental plan, and a company environmental plan that describes in practical terms how a facility will meet its industry's goals. Many signatory

companies have revamped their process technologies to come into "compliance" with their covenants; these companies must also measure and report their progress on an annual basis to the government. The government, for its part, uses the covenant as a basis for revising industry sector guidelines and issuing new permits to the firm.

The Dutch began laying the foundation for this approach in the mid-1980s. Officials say their most recent national survey shows that the Netherlands has succeeded in reducing its environmental burden, while continuing to enjoy economic growth.

Analysis of the Covenant System

The Dutch government, in its book *Silent Revolution* and on its web site,[7] clearly lays out what it sees as the foundation necessary for the success of its sector-based environmental policy.

First, this society has a strong tradition of progress through consensus building. The process has helped ensure that all stakeholders stand behind the decisions made. Each participating group also brings different technical, practical, and cultural skills to the negotiating table, all of which have proved necessary to the success of the program.

Second, industry in the Netherlands is already heavily regulated and enforced, but the regulations themselves tend not to be prescriptive, instead allowing industry flexibility on how it reaches previously agreed on goals. Government does not impose process technology or management style on the companies. Interestingly, covenant participants have observed that

> . . . more laws, stricter standards, and better enforcement have not proved wholly effective in protecting the environment: the legislative process is slow, and compliance and enforcement can conflict with business interests. Both government and industry recognize the need for an approach that is complementary to regulations and would allow greater speed, flexibility, and efficiency at every level and deliver real environmental improve-

[7] Government of the Netherlands (1998b) and <http://www.netherlands-embassy.org/nl-envm.htm>.

ments."[8]

Spin-off benefits from the covenant system have included work on such widely known environmental concepts as life-cycle assessment, environmental product standards, benchmarking, and technological innovation.

Third and perhaps most important to the bottom line, officials say the success of the covenant system demands substantial investment in government staff. Without manpower properly trained in negotiating and integrated thinking, the consensus approach to environmental improvement has no chance. Even with training, the transition to a new approach can be difficult. Dutch environmental officials on the "enforcement side," who did receive training in negotiation and counseling that their responsibilities might change, have reported difficulty fitting into the new system and often are not sure what they are supposed to do. Everyone agrees, however, that these officials continue to play an important role and "must be given a wider scope for a measured approach to their task and indeed be permitted to make the occasional mistake!"[9]

The logical outcome of the covenant system is ultimately to limit the need for governmental intervention, because "we must create a situation in which we no longer need to think in terms of pollution control and protecting the environment but can confine environmental policy to management and development" by the companies themselves.[10]

As exciting as the possibilities presented by the covenant system may be, one must remember that the consensus-building approach heavily emphasized by civil society in the Netherlands differs greatly from the industry development approach in the Asia-Pacific region. Although key elements of covenants may have some usefulness in Asia, it is perhaps better, for the purposes of this report, to look first at examples already developed in Asia of industrial development and environmental protection

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8 The Royal Embassy of the Netherlands (1999).

9 *Op. cit.*

10 *Op. cit.*

to see how far Asian governments have come and how far they have to go. One can then more easily decide whether a new environmental protection model that revolves around industries as sectors can be developed that fits the needs of Asian economies.

The authors have, thus, organized this report as follows: Chapters two and three highlight how environmental and nonenvironmental agencies, respectively, are already using some sector-based approaches in the Asia-Pacific region. Approaches developed elsewhere with possible application in Asia are also discussed. Throughout this discussion, the authors draw on examples from the Asian electronics industry (see appendix A for detailed background), specifically semiconductors and printed circuit boards, to provide tangible and useful evidence of real, interesting, and innovative programs. Chapter four then identifies some key policy interventions, whereas chapter five makes preliminary recommendations for creating this new public policy model in Asia.

CHAPTER 2:

NATIONAL ENVIRONMENTAL REGULATORY STRATEGIES BY SECTOR

In the Asia-Pacific region, the bulk of environmental work undertaken in the public arena takes place in conjunction with a ministry of environment, environmental protection agency, or environmental department. Much of the work is regulatory in nature, determining industrial land and water usage, placing restrictions on pollution emissions, and ensuring compliance with these rules. These activities are sometimes referred to as "core functions" and include:

- *Rule making and regulation.* This a process through which public officials set pollution emission standards. It tends to focus on the manufacturing facility itself, although the process can also focus on products (see box 2 below).

- *Permitting.* Governments designed the permitting process to enable economic growth while protecting environmental quality. Permits are specifically designed to allow activities that may affect environmental quality but require control or even mitigation to minimize the impacts to public health and natural resources.[11]

- *Compliance enforcement and assistance*. Once an agency issues a permit, officials are then responsible for verifying compliance with its language. Officials have a range of enforcement options for the violations they find, sometimes including closing a facility, issuing fines, or filing lawsuits. Officials may even provide technical assistance to bring the offender into compliance.

These techniques are theoretically broad enough to give public

[11] State of Florida (1999).

officials quite a bit of leeway in implementation. Government agencies can choose one of several basic methods to implement such core regulatory functions, among them, media-based programs (focusing on air, water, or waste) and two approaches that augment them: place based[12] (for example, targeting operations in wetlands or watersheds) and sector based.

This chapter will track the progress that some environmental agencies have made in moving from media-based to sector-based approaches in their regulatory work, highlighting the electronics industry (see box 1 and appendix A).

Media-Based Programs

Most countries, regardless of economic status, have historically relied on media-based regulatory approaches to promote compliance with environmental standards—setting and enforcing environmental regulations and organizing their legislation by media: water pollution control, air pollution control, toxic substances, and waste disposal.

Why they have done so is clear: their economic systems do not value the environment as an economic good. Absent environmental regulation, these economies, therefore, use the environment as a "free good." In this system, the costs of compliance are typically only incurred *after* pollutants are created. Environmental expenditures focus on minimizing rather than preventing the negative consequences of pollution, waste accumulation, or contamination. This "command and control" approach to regulation, thus, unintentionally decouples the value of environmental gains from their costs, because compliance is required regardless of its benefits. A good part of the regulated community has viewed this approach as a burden and a drain on productive business activity because the benefits have not been clear.

In sum, traditional, media-based regulations:

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[12] See *Place-Based Public Policy: Developing, Managing, and Innovating for Sustainability* (US-AEP 1999) or <www.usaep.org/policy/report.htm>.

Box 1. The Electronics Industry and the Environment

The electronics industry, highlighted throughout this report, represents well other industries to which sector-based approaches may be applied.[13] The industry demonstrates a range of activities (from low-end assembly operations to high-tech research and development [R&D]), generates revenue in both export and domestic markets, benefits from intentional policy planning at the highest levels, and partners with government, suppliers, and nongovernmental organizations (NGOs) to grapple with sustainable development issues. The industry enjoys fast growth and could serve as a "proving ground" for the sector-based opportunities discussed in this report. Any pilot projects would quickly prove or disprove their merit.

Electronics firms manufacture an extensive range of consumer products (cellular telephones, computers, fax machines, televisions, and CD players) that include such components as semiconductors, printed circuit boards (PCBs),[14] display technology (cathode ray tubes and flat panel displays), batteries, transformers, and generators.

This report focuses on two of the primary electronics subindustries—semiconductors and PCBs—as the most prominent segments of the industry and the ones confronted with the most serious environmental challenges. Semiconductors serve as the brains in advanced electronic controls and devices and have become increasingly prevalent in consumer and industrial equipment. The manufacturing process involves five steps: design, crystal processing, wafer fabrication, final layering and cleaning, and assembly.[15] PCBs are the physical structures on which semiconductors are mounted. The manufacturing process entails five steps: board cleaning and surface preparation, catalyst application of conducting coatings (plating), pattern printing and masking, electroplating, and etching.[16]

Electronics firms present environmental issues in management, manufacturing, and disposal processes that affect factory workers, local communities, and consumers.

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13 Appendix A provides more detailed background on the electronics industry.
14 Also known as printed wiring boards (PWB).
15 Bartos and Burton (1999).
16 USEPA (1995a) and Government of Hong Kong (1995a).

Management. Across the region, a consulting industry has sprung up to support the environmental, health, and safety needs of the electronics industry. Many of these efforts are a response to 1996 factory fires that devastated two semiconductor fabs (semiconductor fabrication facilities) in Taiwan's Hsinchu Science Park with losses of more than $500 million.[17] Despite greater attention to safety procedures in facilities, critics still contend that Taiwan's massive fab buildup in recent years looks like a disaster waiting to happen.

Manufacturing. The building blocks of this industry, including semiconductors and PCBs, have been considered relatively "clean" environmentally, compared with other industry sectors. Nonetheless, electronic component manufacturers use highly toxic, hazardous substances, posing significant potential risks to human health and the environment[18] (see appendix D for a list of such chemicals).

A "clean" production environment is essential to high-quality semiconductor production. Cleaning operations precede and follow many manufacturing steps. Wet processing, in which semiconductor devices are repeatedly dipped, immersed, or sprayed with solutions, is commonly used. Sulfuric acid and hydrochloric acid, used in etching and cleaning, are two of the most commonly released chemicals. Solvents, such as acetone, glycol ethers, xylene, and freon 113, are used in photolithography and cleaning. Degreasing and cleaning releases a great deal of methyl ethyl ketone.[19] Environmental concerns in PCB manufacturing include chemical waste, large volumes of contaminated wastewater, and air pollution (from etching solutions, solvents, and photoresist developers).

Waste disposal. The electronics industry generates toxic and hazardous solid and liquid wastes. Solid wastes consist of metal scraps, empty chemical containers and sludges; liquid wastes include spent process solutions, such as plating solution, degreasers, rinse water, and floor washings. Inadequate wastewater disposal from this industry in the United States has sometimes contaminated drinking and ground water. Asian government officials are studying public policies and disposal techniques to prevent this in their own com-

[17] In this report, all references to dollars are U.S. dollars, unless specified.
[18] Tomorrow Publishing AB (1999b).
[19] USEPA (1995a).

munities.

- Tend to focus on single media issues (air, water, or waste)
- Typically function in a prescriptive manner, without providing industry the flexibility to reach compliance efficiently and cost-effectively
- Create a baseline mentality: industry aims to comply with fixed pollution-load standards, but no higher
- Affect industry sectors, of course, but regulators do not normally develop regulations to emphasize certain industry sectors.

Sector-Based Approaches

Why did policymakers identify the need to move beyond media-based regulatory strategies? Despite ever-improving production efficiencies and process technologies, residents of the international community and Asia-Pacific region, in particular, have voiced fears that the rapid rate of industrial growth is outpacing and will continue to outpace the ability of technology and environmental management systems to prevent the release of pollutants or even mitigate their effects. Recent analysis of industry in East Asia, China, and India shows that despite the quick rate of economic and technological advances, the overall pollution emission rate is growing much faster.[20] Even with the Asian economic crisis, these overall trends in pollution loads will presumably continue unabated without additional policy intervention.

U.S. officials identified the need for the regulatory system to evolve when they began to notice rapid growth in nonpoint source environmental problems, increased availability of innovative policy tools and technological advancements, and increased sophistication and knowledge base among environmental stakeholders. Likewise, some governments in the Asia-Pacific region have recognized the need to go beyond single-media, command-and-control regulatory strategies as the intense development of the manufacturing sector has generated additional

[20] Drake (1999).

wastes and increased the number of polluting sources.

Many countries, including those in Asia, currently enforce environmental legislation that is directed essentially toward pollution abatement. Focused primarily on conformance with emissions standards, this approach has contributed significantly to the many successes that have been achieved in upgrading environmental quality. In the short term, it remains an effective means of compelling polluters to control their various sources of pollution according to set environmental goals. It is not, however, an ideal approach in the modern concept of long-term environmental management, because it has resulted in the transfer of pollutants, particularly those categorized as hazardous, from one medium to another.

Sector-based approaches are already appearing in core regulatory functions of countries around the world. The following describe a few examples of sector-based regulations already in place in the Asia-Pacific and the United States. Although in no way complete, these descriptions provide a flavor of the kinds of innovative programs that public policymakers might want to consider as part of a more comprehensive regulatory approach.

Sector-Based Rule Making and Regulations

Relevant examples on rule making and regulations involve water and air pollution concerns as well as disposal of products at the end of their life:

Water. Water scarcity issues are high priority items in most countries throughout the region and affect development issues in places as diverse as urban communities, traditional agriculture, and high-tech industries. As such, water use is one of those issues in which multiple sectors have conflicting interests. For instance, water shortages have become critical in Taiwan, particularly during the summertime. Residential communities, thirteen fabs, and agricultural operations in Taiwan vie for the same water supplies, which has led communities and farmers to protest the voluminous use of water that is required by Taiwan's semiconductor industry. Sector-based regulation is, therefore, par-

ticularly appropriate. In response, the government has become stricter on water policy related to the semiconductor industry, requiring its manufacturing facilities to recycle at least 70 percent of the water used in production. Industry has already surpassed these requirements, reporting success rates of more than 90 percent, although the Taiwan Semiconductor Industry Association has approached the Taiwanese government to request construction of more reservoirs and dams near Hsinchu Science Park as the country strives to complete its twentieth fab by the year 2000.

Air. Among its duties, Taiwan's Environmental Protection Administration (Taiwan EPA) sets ambient air emissions goals and has announced new standards for volatile organic compounds (VOCs)—which will go into effect July 1, 2000—specifically targeting the semiconductor industry. The semiconductor manufacturing industry in Taiwan consumes 11,500 tons of VOCs annually. Many pollution control systems now in place do not effectively control VOC emissions, leading to annual emission volumes of around 3,000 tons in Taiwan. The industry also uses 12,500 tons of inorganic acids each year, although wet scrubbers keep much of these waste emissions from entering the environment. Total releases of inorganic acids as gases by the semiconductor manufacturing industry in Taiwan is approximately 600 tons per year. The new standards target integrated circuit manufacturers, wafer packaging and wafer stacking firms, semiconductor masking firms, and circuit frame manufacturers, which must meet the emission standards for pollutants listed in table 1.

Officials believe that compliance with these standards will result in an estimated reduction of 2,700 tons per year in VOC and acid gas emissions, improving national air quality and protecting regional public health. As new operations in Taiwan's southern science park come on line, Taiwan EPA predicts that reduction in volumes under these regulations should reach 6,000 tons per year.[21]

[21] Taiwan EPA (1999b).

The standards also require firms consuming 50 or more tons of

Table 1. Taiwan Air Emission Standards for Semiconductors

Air Pollutants	Emission Standards
Volatile organic compounds	Emissions reductions greater than 90 percent or total factory emissions less than 0.6 kg/hr
Trichloroethylene (C_2HCl_3)	Emissions reductions greater than 90 percent or total factory emissions less than 0.2 kg/hr
Nitric acid (HNO_3), hydrochloric acid (HCl), phosphoric acid (H_3PO_4), and hydrofluoric acid (HF)	Emissions reductions greater than 95 percent or total factory emissions less than 0.6 kg/hr
Sulfuric acid (H_2SO_4)	Emissions reductions greater than 95 percent or total factory emissions less than 0.1 kg/hr

VOCs annually or releasing more than 0.6 kg of VOCs per hour to install monitoring instruments. Firms are responsible for recording monthly input and emissions totals for VOCs and inorganic acids as well as any reductions in usage. All related data must be submitted each quarter to local authorities and retained in company files for a period of at least two years. To facilitate industry compliance, Taiwan EPA held seminars in Taipei and Kaoshiung cities on the legal and technical aspects of the new regulations in early 1999.

Taiwan EPA estimates that approximately seventy firms in the semiconductor industry will need to upgrade pollution control facilities to meet compliance requirements. Of these, approximately twenty will need to invest an estimated total of more than NT$1 billion[22] to install appropriate VOC control equipment. Another fifty firms must spend approximately NT$200 million to improve current inorganic acid treatment facilities.

[22] The exchange rate as of August 28, 1999, was US$1 = 31.9 New Taiwan (NT) dollars.

Taiwan EPA used several techniques to develop and launch this

Box 2. Sector-Based Take-Back Laws

The development of legislation and regulations targeting products themselves—not just facilities—can also come under the purview of a regulatory agency. Such regulations are, by definition, sector-based in nature. For example, in this world of rapidly changing technology, the disposal of computers and other electronic equipment has created a growing waste stream. Increasingly, governments are intervening with products' end-of-life disposal processes, believing that consumers have the right to return an outdated product to its manufacturer and that corporations have the responsibility to keep that product out of landfills. A successful program, therefore, depends greatly on corporations' sense of social responsibility and the education of both producers and consumers. This has forced companies to reexamine their products, which has inevitably resulted in cooperation with suppliers.

The design challenge is increased when products are sold internationally and will be subject to the disposal restrictions of the jurisdiction in which they reach the end of their life. Mandatory product take-back schemes, such as those that will be enacted by European Union member states, will require manufacturers to *(a)* take back, free of charge, products such as appliances, information technology equipment, and consumer electronics from users at the end of the product's useful life and *(b)* manage the product returned in an environmentally sound manner. Furthermore, the program is expected to significantly impact not only how the electronics industry manages restricted material use in products (possibly requiring the phaseout of materials such as lead and mercury from electronic products), but also municipal governments responsible for collecting and sorting the items.[23]

The United Kingdom's mobile phone industry announced a national campaign in December 1998 to ensure environmentally friendly recycling of old mobile phones. The "Take Back" scheme will be run under the auspices of the European Telecommunications and Professional Electronics Industries Association in conjunction with ten industry partners: Alcatel, BT Cellnet, Ericsson, Motorola, Nokia, Orange, One 2 One, Panasonic, Philips, and Vodafone. Part of industry's participation includes a re-evaluation of the product design (striving

(continued)

[23] Krut (1999).

for components that are easy to break down and made from non-toxic materials) and a study of the cost of reclamation. The recycling process will be undertaken by a private company responsible for ensuring the safe disposal of hazardous substances and provide a full financial and environmental audit trail. Transport logistics are being provided by a second company that will oversee the collection of handsets from the recycling points for delivery to the recycler. Germany's Parliament is considering a similar program.

Take-back regulations have not been implemented outside of Europe, but policy in the United States at the moment favors voluntary measures to achieve the goals of the European legislation.[24] Departments of environment at the state level are developing their own product take-back and recycling programs for electronics and include efforts in Florida, Maine, Massachusetts, Minnesota, New Hampshire, and South Carolina.[25]

Take-back laws have appeared in Asia as well. Despite the economic difficulties facing Japan's Big Five electronics firms—Toshiba, NEC, Hitachi, Fujitsu, and Mitsubishi Electric—Japan's Parliament has passed "take-back" legislation that requires electronics manufacturers to accept used equipment and recycle or reuse parts in new products. IBM Japan unveiled such a take-back program three years ahead of the legislation. Within the last year, Japan has passed packaging laws that specifically target cell phone packaging as well. Taiwan also recently enacted take-back regulations for electronics and appliances (televisions, washing machines, refrigerators, and hand phone batteries). In Taiwan, the manufacturer pays the take-back fees.

The Hong Kong Productivity Council (HKPC) has the responsibility for tracking and preparing Hong Kong's Industry Department and local manufacturers for "the impact of pending international regulations on recyclable requirements of electronic and electrical products. HKPC is collecting information on regulatory trends requiring contents of electronic and electrical equipment (particularly consumer items) to be recycled and is preparing a report how this

[24] *Op. cit.*
[25] Electronics Industry Alliance (1998).

will affect manufacturers of electronic and electrical products."[26]

policy, including a scientific investigation into current semiconductor industry air emissions and control technology, professional conferences focusing on semiconductor industry emission standards, and discussions with stakeholders, although much criticism remains concerning the conclusions of the scientific study. In November 1998, targeted firms expressed their concerns to Taiwan EPA about the standards' requirements for installing VOC concentration detection equipment, arguing that these requirements created difficulty for them, because this type of air pollution detection equipment was not yet available on the market. Semiconductor firms also commented that the standards placed an excessive investment burden on small manufacturers, thereby weakening their competitiveness. As a result, the control targets of the emission standards were defined as being for large manufacturers and the implementation date was extended. The standards stipulate that existing facilities have three months from the date of announcement to file pollution control plans with competent local-level authorities.[27]

Sector-Based Permitting

Truly sector-based permits are multimedia in nature, setting simultaneous standards for air, water, and waste. This approach means that improvements in one area will not result in unacceptable loss of performance in another area.

One of the most innovative permitting examples that the United States has to offer involves Intel Corporation's facilities in Arizona under a USEPA initiative called "Project XL." Project XL (eXcellence and Leadership) is a national pilot program begun in the United States in 1997 to effect "stronger environmental performance, meaningful stakeholder involvement, and regulatory flexibility."[28] It combines regulations on air, water, and waste

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[26] Government of Hong Kong (1998).

[27] Taiwan EPA (1999b).

[28] USEPA (1997a). Project XL focuses on other core regulatory functions in addition to permits. It also enjoys participation from other companies besides Intel. See <www.epa.gov/projectxl> for more information.

into a single, facility-specific environmental plan and allows firms flexibility in meeting superior performance goals by negotiating pre-set, approved emissions levels and allowing increased manufacturing capacity that falls within such levels. USEPA administers the program and makes a simple offer to companies: "If you have an idea that promises superior environmental protection to what would be achieved under the current regulatory system and if you use a meaningful stakeholder involvement process, then we will work with the relevant state and local agencies to grant the flexibility needed to put those ideas to the test."[29]

Critics of Project XL contend the initiative is not administered broadly enough across geographic regions or inclusive enough of a wide range of companies to serve as a fail-safe model for regulators to use. Thus far, it has focused quite narrowly on just a few facilities.

Sector-Based Enforcement and Compliance Assistance

USEPA's Compliance Assurance Sector-Based Targeting programs identify on a biannual basis those sectors with a history of environmental noncompliance. For fiscal 2000–2001 high-profile sectors are coal-fired electric utilities, animal-feeding operations, metal services, and petroleum refining. At the local level, Florida's Department of Environmental Protection uses sector-based approaches to help facilities come into compliance with environmental regulations, which means it conducts quarterly evaluations to determine which industry sectors are falling behind in their environmental responsibilities. The department then has the leeway to redirect budget, staff, and other resources into compliance assistance activities.[30] The secretary of the agency produces on a quarterly basis a report that analyzes ambient measures of air, water, and surface quality by geography and then ranks companies' environmental performance and helps staff determine where they need to focus agency resources in

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[29] USEPA (1997a).

[30] Stephen Adams, senior management analyst for strategic projects and planning, Florida Department of Environmental Protection, Sept. 23, 1999.

enforcement and compliance assistance activities. This program began two years ago with a primary focus on regulation by media and has begun to evolve into a program that focuses on statistics and programs unique to industry sectors themselves. Agency staff hope to have the program fully converted to a sector-based program by 2001.[31]

Recognizing the need to develop industry sector information for both regulatory officials and regulated industries, Taiwan EPA's Office of Compliance created industry "sector notebooks," which include general industry demographics, a description of the manufacturing process, related environmental issues and regulations, and a description of relevant partnerships that have been formed among regulatory agencies, the regulated community, and the public.[32] The sector notebook describes in some detail the manufacturing processes used in electronics and enumerates the chemicals and environmental hazards involved in such processes. It also tracks a decline in the toxics released by electronics manufacturing industries over time. More recently, USEPA has posted its version of "virtual sector notebooks" on the Internet for use by a wider audience.[33]

Conclusions and Recommendations

What kind of foundation would have to be in place for governments to take a more sweeping sector-based regulatory approach? In the Dutch case described in chapter one, participants recommend starting with an enforcement-intensive environment that has good monitoring and measurement systems in place. Then, on top of those, they suggest building measurement programs and a transparent system for stakeholder participation.

With few exceptions, such as Singapore, countries in the Asia-Pacific region have passed strongly worded environmental legislation, but enforcement is weak. This situation has intensified with budget cuts during the economic crisis; environmental

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31 See <www.dep.state.fl.us> for copies of the latest "Secretary's Quarterly Performance Report."

32 USEPA (1995b).

33 See <es.epa.gov/cooperative/international>.

agencies have too few people chasing after too many problems.

Should governments undertake a serious push to move to a sector-based approach within the environmental ministries responsible for environmental regulation? Probably not in a full-fledged program, given current structural weaknesses that prohibit the countries from meeting the criteria set in the Dutch model. It may be that the economic development ministries and agencies are better positioned, as part of their planning process, to develop more of a holistic sector-based approach to sustainable development. These offices interact more frequently and cooperatively with the private sector and have many elements already in place for using a sector-based approach. In fact, it is the huge problem of inadequate, government-provided environmental infrastructure, such as hazardous waste treatment sites, that largely overwhelms industry's ability to comply with environmental regulations in the first place (especially for SMEs and companies outside industrial estates). The next chapter deals with these planning issues in greater detail.

CHAPTER 3:

SECTORAL PLANNING: BALANCING GROWTH AND ENVIRONMENT

Chapter one demonstrated the Netherlands' established success in using sector-based environmental policy to encourage a wide range of improved industrial behaviors at the national level. Chapter two showed how other places have begun to use bits and pieces of a sector-based approach in their environmental regulatory strategies and agencies. The United States, in particular, has experimented quite a bit with pieces of this approach in environmental regulation; however, these efforts have had a mixed record of success. Much of the criticism has centered on the limited scope of these experiments and pilot projects and the expense required in staff time and resources for their administration. Still, because of potential economic and environmental benefits, sector-based work in the United States remains one focus of current and future USEPA "reinvention" efforts.

These potential benefits could also be gained in Asia, where policymakers have already expressed an interest in this approach, evident in the sector-based examples, mentioned throughout chapter two, that are being implemented piecemeal in different countries. At first glance, some might say that sector-based environmental policy will not work particularly well in the Asia-Pacific region. National environmental plans, which are the basis for the Dutch covenant system, are likely in Asia—if they exist at all—to be underpinned by comparatively weak environmental ministries, compared with their counterparts in the Dutch and U.S. examples. This weakness has been further exacerbated by the Asian economic crisis.

At the same time, Asia has a number of strengths that may enable it to recast sector-based approaches developed elsewhere into something that its governments can apply. This chapter ex-

plores both the weaknesses and strengths that will determine whether Asia can effectively implement a sector-based approach to environmental protection.

National Environmental Policy-Setting in Asia

Many of Asia's national governments have created national environmental plans for the medium and long term. These plans can cover a wide range of activities—from resource conservation and land planning to energy efficiency and manufacturing pollution reduction and prevention. They originate in the highest environmental bodies, which are often at the ministerial level or higher.

Much of the environmental language currently used by national governments actually came out of the United Nations Agenda 21 program. Some national governments are creating their own Agenda 21 programs. Indonesia's, for instance, describes ten national steps toward environmental management and sustainable development and includes broad goals such as protection of the environment, increased community participation, and anticipation and reliance on economic and environmental information. Most every government that documents an environmental plan, describes the environment broadly, including issues related to natural resource extraction and protection, as well as industrial environmental behavior.

Some environmental planning documents are part of a broader national plan. Malaysia's environmental vision for the next generation is part of "Vision 2020," developed through the Prime Minister's office. Singapore's "Green Plan," scheduled for publication in 2000, is a second generation document created through the combined efforts of the Ministries of Environment, Trade, National Development, Communication, and Public Health that spells out national development goals.

Other countries' planning documents are more specifically geared to the environment. Taiwan's environmental planning document was produced by members of the Executive Yuan, an advisory body to the president, whereas Korea's Ministry of En-

vironment produced an environmental "Vision 21." Thailand has an "Environmental Management Master Plan 1999–2006" developed by the Ministry of Science, Technology, and Environment, and the Philippines has a two year-old "Sustainable Development Strategy" developed by the Department of Environment and Natural Resources. The Vietnamese government is currently writing an environmental plan through the Ministry of Science, Technology, and Environment's National Environmental Agency.

These plans have been implemented with varying degrees of success. For instance, Singapore has a longer and more substantial history in environmental management than any other country in the region; this city-state's pollution control department was first established more than 30 years ago. Today, the environmental authorities play an important role in the country's master plan. As a result of strong political support and long-term planning, Singapore is more advanced in terms of environmental technology than most Asian countries. Korea and Taiwan have made relatively good strides in this area as well.

The Philippine plan, strategically designed and innovatively written to begin to decentralize some environmental responsibility by placing greater authority in the hands of provincial governments, is highly regarded by the international community for its judicious balance of industrial growth and environmental protection. The document, however, has not in practice shaped environmental public policy to the extent its authors intended.

In countries where the environment plays a subordinate role to line ministries such as trade, industry, or finance, environmental plans have had a particularly difficult time getting off the ground. In answer to critics who contend that the Indonesian government has placed a low priority on the environment compared with other issues, former Minister of Environment Sarwono Kusumaatmadja has reasoned that environmental consciousness is a relatively new concept in Indonesia, largely regarded as an appendix to government. Headed by a state minis-

ter, the environmental agency is one level below a "regular" minister in the hierarchy.[34] Vietnam is another country with a national environmental agency that operates at a level that is more "junior" than other issues areas. Officials have recently debated the merits of upgrading this environmental body to a general department or even ministerial level. The Asian economic crisis has hobbled environmental agencies still more, as budgets decreased in some instances by 50 percent, affecting a wide range of monitoring and enforcement activities.

Asian Strengths Supporting a Sector-Based Approach

Given the concern regarding relatively weak institutional capacity of environmental ministries in Asia, is there any hope for pursuing sector-based public policy there? Fortunately, several strong reasons support pursuit of a sector-based model in the region; Asian-Pacific countries have their own unique set of strengths and capabilities that they can use to tailor this approach to fit their own experiences and make it viable. Three strengths, in particular, make the possibilities for this approach exciting: the strong institutional capacity of industrial development agencies; a new, emerging tradition of public participation; and use of industry-specific location policy (using industrial estates) as a development model that is more formal than in the United States.

Industrial Development Agencies and Policies

Perhaps the most important reason for optimism in applying a sector-based model in Asia is the strong national capacity among Asian governments for industrial development. In contrast to the United States, countries in Asia have rigorous, detailed industrial development plans backed by strong ministries (industry, finance, and so on). In fact, countries throughout the Asia-Pacific region have mapped out visions for themselves describing what role they would like to see their economies play in the future (see box 3). Singapore wants to be an R&D Center for the Asia-Pacific region and has identified twelve business clusters—in-

[34] Chairul, Carl. 1999. "Who Has the Right Stuff to Manage the Environment?" *Jakarta* Post (September 21). Jakarta, Indonesia.

cluding electronics—that it can help facilitate. Taiwan sees itself as a fully industrialized nation by 2000. Malaysia's long-term developmental goal is called "Vision 2020," by when it hopes to

Box 3. National Visions for the Electronics Industry

Every national government in the region that sets industrial development policy has something to say about electronics, which is viewed as an industry capable of helping to fulfill a national "vision." Countries throughout the Asia-Pacific region have not only announced impressive goals for their electronics industries, but also reserved resources and implemented policy programs to ensure their success. According to Nyoman (1998), "The electronics industry will soon become the largest contributor to the global market [and] is growing rapidly at a rate of about 6–10 percent each year. As the unit price of the product drops by about 2–6 percent per year, this results in a growth rate of approximately 8–16 percent per year in terms of quantity of electronic components assembled." Even during Asia's economic crisis, its electronics industry managed measurable growth rates due to sustained world demand for electronic products.

Korea, Taiwan, and Singapore make up a top tier of Asian-Pacific countries that have aggressively developed advanced electronics industries, supported by the strong public policies of their national governments. Among the world's electronics powerhouses, Korea holds 35 percent of world market share in memory semiconductor chips and Taiwan manufactures and sells more than 70 percent of the world's computer PCBs.

Korea. For decades, the Korean government provided broad support to Samsung, LG, and Daewoo, three major industrial conglomerates or *chaebols* accounting for 45 percent of Korea's total sales and 20 percent of the domestic electronics workforce. Difficulties obtaining electronics components in the 1980s forced these companies to develop their own electronic manufacturing equipment. Building on their success as leading producers of microwave ovens and other consumer items, Korea is now developing leadership in the liquid crystal display business.

Taiwan. Taiwan has developed its electronics manufacturing capabilities through companies smaller than Korea's *chaebols,* although the government did play a pivotal role. Until recently, the government had a policy to incubate and spin off high-tech in-

dustries. Taiwan Semiconductor Manufacturing Company is the most high-profile example.

(continued)

The government changed its policy in 1998 after complaints from private sector companies about government-created competition in their industry sector. Today, Taiwan is targeting the markets for integrated circuit design, optoelectronics, displays, packaging, and semiconductors. Taiwan has made semiconductors a major priority and plans to have more than twenty wafer fabs by the year 2000.

Singapore. Singapore is one of the largest assemblers of integrated circuit packaging in the world and started in the electronics business in the late 1970s by assembling final products and subsystems.[35] The electronics industry accounts for 51 percent of Singapore's GDP and 43.7 percent of the country's total manufacturing output. Traditional hard disk drives, semiconductors, computers, and consumer electronics remain the dominant product segments and represent about 76 percent of Singapore's $45 billion in electronics output alone. Still, Singapore is growing in the area of advanced products and technologies driving data storage, computing, and wafer fabrication. It has nine wafer fabs in operation, but plans to more than double its operations with twenty fabs in place by the year 2005. Singapore's electronics industry is undergoing a transition, as the government is encouraging multinationals to locate R&D facilities in Singapore. By the late 1980s, Singapore manufacturers had already moved many of their production lines to Johor, Malaysia, and Batam Island, Indonesia, as building rental and labor costs rose in Singapore.

Other countries. A second tier of industrializing countries in Asia includes relatively recent newcomers to high-value electronics production—Indonesia, Malaysia, Philippines, and Thailand. These countries now host quite a few of the multinational production lines from around the Asia-Pacific region, Europe, and the United States and rely quite heavily on international markets to support their electronics production. Indonesia and Thailand in particular rely on imports of major components and equipment and on joint ventures with foreign firms to build basic capabilities.[36] These countries are working to improve relevant educational curricula, management, and analytical skills.

[35] Boulton and Kelly (1997).
[36] *Op. cit.*

be fully developed in all aspects—industrially, environmentally, spiritually, psychologically, and culturally. Already, its officials report that "the electronics industry has taken the lead in fueling the manufacturing push and attracting significant foreign direct investment. That augurs well for the future development of the industry as bigger corporations are more likely to inject advanced technologies into their operations."[37]

The national industrial planning process in the Asia-Pacific region varies widely, involving many more democratic institutions in the Philippines than, say, in Vietnam and different economic strengths, for example, in Taiwan compared with Indonesia. One thing they all have in common, however, is that industrial development planning is a rigorous process that occurs at the highest national levels. In Malaysia, for example, the prime minister chairs the body with this responsibility, the National Development Council. In the Philippines, the president heads the National Economic Development Authority. Both planning bodies have identified advanced electronics as a priority sector for rapid development in the next several years. In both countries, as well, the national industrial planning documents acknowledge the threat of environmental degradation and promise environmental protection. Insight into the national industrial planning processes of these two countries is provided below.

Malaysia's experience. The Economic Planning Unit (EPU) of the Prime Minister's Department, the central agency for development planning in Malaysia, serves as the nerve center for formulating national policies, encouraging the growth of target industrial sectors (including electronics),[38] and determining what kind of technology, human resources, education and training, physical infrastructure, and funding for research and develop-

[37] Pola Singh (1999).

[38] In the case of Malaysia, electronics and electronic products account for about 60 percent of its manufactured export value and grew annually from 1996 to 1998 by 18.7 percent and by 6 percent continuing into 1999–2000.

ment is needed.[39]

EPU officials stress that development planning in Malaysia involves a high degree of coordination and cooperation among various ministries and agencies as well as the private sector, NGOs, and academicians. Officials take particular pride in the fact that planning in Malaysia is a two-way, interactive, top-down, *and* bottom-up process. Planning from the top is confined to setting macro-level parameters by central agencies, such as EPU, Treasury, Central Bank, and the Statistics Department. These parameters include the targeted growth rate of the economy for the next five years, rate of growth of specific sectors, and employment rate. Top-down planning also involves estimates of financial resources that will be made available. Planning from the bottom involves the various ministries, agencies, private sector companies, and NGOs that provide valuable feedback and identify the pressing development needs of the various industries and regions. It is here that macro parameters are translated into sectoral plans, programs, and projects. EPU plays a key role in matching the micro-level programs and projects with previously determined macro-level parameters for all the economic sectors.[40] Officials say that, at the national level, the momentum behind much of their economic planning is led by the private sector.[41]

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[39] EPU is assigned the following functions: formulate policies, programs, and strategies in development planning; prepare long- and medium-term plans; prepare and evaluate the five-year development budget; advise the government on economic issues; initiate economic research; and prepare projects for privatization.

[40] Pola Singh (1999).

[41] One "danger" officials note, however, is that the Malaysian electronics industry is dominated by multinationals, which has resulted in lopsided development of the industry with a relatively strong foreign-controlled sector and weak indigenous sector. Although the electronics industry is performing well in Malaysia, local company participation is still below expectations. In addition, the government of Malaysia notes that the concentration of activities remains at the "back end" or package and assembly operations. As a result, the government is encouraging provision of special incentive packages to increase development of "front-end," technically demanding activities such as wafer fabrication.

In addition to all these efforts, however, Malaysia also recognizes that

> . . . additional programs and action might be required by the states to ensure sustainability at the state level. Because such actions will result in additional costs to the states concerned but have spillover benefits to other states and the nation as a whole, the government [is studying] methods of estimating these additional or incremental costs that are borne by the states, with a view toward funding them where appropriate, as an incentive to the states to implement actions with wider sustainability benefits.[42]

The Philippines. Formulation of the 1999–2004 Medium-Term Philippine Development Plan falls under the overall direction of the President's National Economic Development Authority Board. Sector-specific planning takes shape under the Philippine Export Development Plan.[43] Part of the Estrada Administration reform agenda is strengthening the linkage between planning and budgeting in all agencies. In its own "1999 Industry Roadmap" (formerly called the "Master Plan"), the Philippine Department of Trade and Industry recently published development plans for eighteen industry sectors, including electronics.

The planning process in the Philippines shares some characteristics of Malaysia's process. Just as Malaysia describes its planning process as cooperative, Philippine officials describe theirs as "collaborative and consultative," with leadership from both government and private sector representatives and involving inputs from various stakeholder groups through the various regions of the country. As such, the planning process requires sufficient time and can be tedious.

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[42] Government of Malaysia (1999).

[43] The Philippine Export Development Plan identifies electronics as one of the Philippines' priority industry sectors and has set a goal to maintain 30 percent export growth each year. To date, the 580 electronics firms registered with the Philippine Board of Investments account for approximately 60 percent of the Philippines' export value; semiconductor products alone represent 30 percent of the Philippines' export value. Thirty-two percent of the Philippines' 1998 electronics exports went to the United States, 13 percent to Japan, and 9 percent to the Netherlands.

Preparation of the "1999 Industry Roadmap" involved a steering committee that included five national government departments including the Board of Investments,[44] which wants to see rapid development of "homegrown" companies, including SMEs. Like Malaysian officials, Philippine officials are concerned that multinational firms that engage primarily in labor-intensive, back-end assembly operations dominate their electronics industry. As a result, the government is trying to increase the value added from local components supplied by local manufacturers to 40 percent. Noticeably, a base is growing of component suppliers, to which Filipino-owned enterprises are providing most of the third-party subcontracting work. A second focus of the road map is to identify and support the growth of niche markets in the Philippines. For the electronics industry, this might be office equipment, such as photocopiers and fax machines. A third area of emphasis is the development of environmental infrastructure, which could be used by the electronics manufacturers that are already concentrated throughout Metro Manila and adjoining regions. Another area of emphasis includes development of human resources—particularly in wafer fabs—through academic linkages to job placement programs and sister schools in Silicon Valley in the United States.

Emerging Public Participation

A second reason that prospects for the use of cluster-based approaches in the Asia-Pacific region are looking good is the growing practice of involving stakeholders. The Philippines, for example, is improving its stakeholder process under President Estrada—a process begun by Presidents Ramos and Aquino before him. Both the Philippine and Malaysian governments have noted increased integration of community groups in their national planning processes.

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[44] The other four departments are the Philippine Economic Zone Authority, the Department of Science and Technology, the Center for International Trade and Exposition Missions, and the Bureau of Export Trade Promotions.

In addition, NGOs increasingly have a political and legal voice, particularly at the local level, where the impacts of production and its attendant pollution are actually felt. For example, in Thailand, in response to local pressure, politicians are increasingly raising environmental concerns while running for office. NGOs and communities continue to pressure government officials, once elected, through phone calls and newspaper articles and are finding increasing support for their efforts. This is particularly the case in Thailand, where the 1997 Constitution includes language encouraging public participation in resource development issues.

Beginning July 1, 1999, NGOs in Taiwan have the right to sue Taiwan EPA if they believe it is not performing due diligence with respect to the environment (e.g., not following up on community complaints within the six months allotted time). Environmental groups are becoming so powerful that politicians have started signing environment-related pledges as part of their campaign platforms. In recent years, Taiwan EPA has closed factories because of public outcry over pollution emissions. An educated citizenry is increasingly searching for and finding a place to appeal.

Public participation helps the official decisionmaking process:

- Develop analytical, informed community leaders
- If done correctly, increase a feeling of ownership and, therefore, project support
- Serve as an early warning device for problems or at least indicate plausible points of intervention.

In addition, stakeholders who already have a seat at the table can bring their own concerns and expertise to bear on current or potential problems.

Industrial Location Planning

The third reason to explore the use of a sector-based model is because many countries in the Asia-Pacific region have actually mapped where they want to locate or concentrate entire indus-

tries. At the local level, similar industrial facilities might be geographically grouped along corridors, near cities, or even in industrial estates. For example, Thailand has designated specific areas in northern Thailand for electronics, ceramics, gems, agroindustry, and metal works industries; in the middle of the country for textiles, paper products, automobiles, and electronics parks; and in the south for steel, petrochemical, palm oil and rubber, food canning, and electronics industrial estates.
Facilities have a natural interest in locating near their competitors, suppliers, customers, and specialized resources. Recognizing this, some government agencies have begun to identify and recruit "industry clusters"—groups of firms in similar and related industries that do business with each other and share needs for common talent, technology, and infrastructure and, therefore, have a common interest in locating near one another. In the United States, for example, where most industrial development planning takes place at the state level, Arizona is planning and recruiting its industry using industry clusters. This "cluster-based" approach, thus, combines place-based (geographic) and sector-based (industrial) approaches.

The point here is to construct policy and approaches that will attract, reach, and measure an entire industry, not just one firm at a time. One example of why this approach could be helpful is the recent outsourcing begun by many manufacturers to move much of the "dirty" manufacturing and disposal processes off site. This improves the manufacturers' environmental statistics and image in the eyes of investors, consumers, and environmental groups. Facility-focused statistics, however, do not portray an accurate picture, because the dirty manufacturing process techniques still occur elsewhere. Evaluating industry as a cluster is good way to "capture" the whole picture, allowing more rational choices related to policy intervention (see box 4).

Cluster-based approaches also increase efficiency in the use of environmental infrastructure, environmental compliance monitoring, enforcement, or assistance. It decreases waste associated with long-distance transport within the supply chain and could

encourage permitting innovations pertaining to entire industrial clusters. In addition, this approach could help steer the process and progress of industrial growth, allowing local government to make informed decisions about its growth rate (e.g., avoiding urban sprawl).

Box 4. Identifying Industry Clusters

Public agencies, such as departments of commerce or environment, that focus on industry activities are beginning to recognize that each local company does not stand alone but is part of a larger production system: The first layer of a firm's value-added chain consists of supplier and service firms that contribute to producing the end product. A second layer partly includes the firm's competitors—firms that produce the same end product but also share the need for common talent, technology, and infrastructure. A third layer is made up of essential economic foundations, such as specialized workforce training entities, research, and development capabilities.

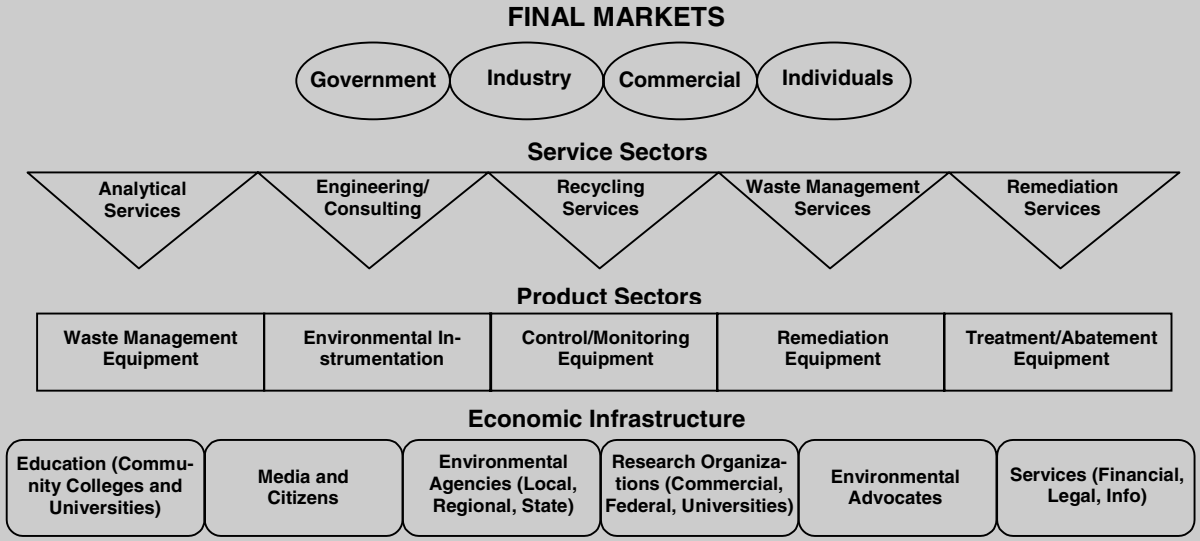
Agencies can draw a "cluster map" to identify the key stakeholders in an industry cluster's success. The cluster map should show the three key components of a single cluster:

- Export-oriented sectors (sectors selling products or services outside the cluster area)
- Support sectors (sectors selling primarily to the export-oriented sectors)
- Specialized community infrastructure (local institutions, assets, and capabilities that support the cluster)

The cluster map for the Silicon Valley environmental industry, shown in figure 1 below, shows these elements organized by final markets, service sectors, product sectors, and economic infrastructure.

Just as it is important to understand how national policy is developed through industrial development and environmental planning, the key to understanding the dynamic picture of geographical economic activity is to discover how, where, with whom, and from whom people and firms acquire information, skills, and knowledge and how they transact business. Determining the flow of information and ideas, value-added chains, and networks within a cluster helps both national and local public agencies make choices related to policy intervention, because the right point of contact could result in impacts up and down the value chain or throughout the cluster network.

Figure 1. Silicon Valley Environmental Industry: Cluster Map



One U.S. locale using industry clusters to direct the growth of its electronics industry is Washington County in Oregon state. Officials there designed a strategic investment program to attract more manufacturers in the semiconductor and steel industries, which are sectors in which Oregon already had a foothold.[45] The county's economic development program has been so wildly successful—boasting Intel, Hewlett-Packard, Integrated Device Technology, and LSI Logic Corporation as tenants—that, in May 1999, the county negotiated a new contract with Intel Corporation to promote investment of $12.5 billion over the next 15 years. A unique component of the agreement would *limit* the company's growth and strike a balance between the community's economic growth and quality of life. The contract stipulates that Intel must establish hiring limits of 5,000 manufacturing jobs or else pay an additional $1,000 in taxes *per extra employee per year*. County officials wanted to make sure that the local government would be able to cover the additional infrastructure costs—that is, police and fire protection and additional roads and sanitation lines—brought by high population growth.

Analyzing industries as clusters suggests that groupings of interrelated firms are the ultimate "customers" of government economic development and environmental protection activities. It further suggests that public agencies can use clusters to focus their resources and initiatives strategically on key industries (e.g., major economic drivers or environmental polluters), involve a wider array of businesses in the design of policy and programs, and disband costly one-on-one service delivery that yields low returns. This view encourages firms to learn from each other and work together to solve their common problems (e.g., workforce training or meeting environmental standards). With this change in perspective, economic and environmental agencies can redefine their jobs to facilitate, catalyze, and challenge more than intervene, subsidize, and regulate. In doing so, public officials seek to work with industry within and across clusters to address common problems and implement initiatives.

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[45] Hamilton and Williams (1999).

Experience in the United States shows that states can assist this "connecting process" in a number of ways. In general, they help companies that compete with each other to collaborate in developing shared talent and infrastructure (e.g., for hazardous waste sites). They are matchmaking, for instance, big company mentors to SMEs, companies to universities, and government technical assistance to a critical mass of businesses. States, such as Arizona and California, put in place formal organizations to engage their key industry clusters in collective problem solving and promotion of their interests. The states of Oregon and Michigan are organizing "networks" of manufacturing companies, modeled after the experience of some successful European countries, to facilitate interfirm interaction and cooperation for product development or value-added purposes.

Collaboration across jurisdictional lines is another key feature of the cluster-based approach. Economic relationships among firms in a cluster clearly follow market opportunities and do not respect political boundaries.[46] Economic activity that crosses political boundaries can be hindered by large numbers of institutions, jurisdictions, and individuals interacting with the cluster, making it difficult to do things quickly and implement fundamental change. As a result, multistate regions are beginning to see that collaboration across jurisdictions has a competitive advantage. They use the cluster model as a way to forge a major commitment to building sustainable relations with industry.

Compared with the United States, Asian governments tend to use the more formal structures of "industrial estates" to house their industries. Some of these locales have taken nicknames that invoke the image of the successful industrial model Silicon Valley in the United States: Penang, Malaysia, publicizes itself as "Silicon Island," and Indonesia has a "Bali Silicon Valley."[47]

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[46] Local trading relationships in Asia have already moved in this direction with the establishment of "regional growth triangles," such as the Indonesia-Malaysia-Singapore Growth Triangle, an area informally dedicated to promoting traditional trade links and jointly developing border areas.

[47] Indonesia touts two additional electronics estates under development. The Electronics Components Industrial Park is planned as a mass manufacturing site with "full infrastructure," ten multinational corporations, ten Indo-

Some Asian countries set aside land for electronics production years ago. In 1980 the Taiwanese government established the Science-Based Industrial Park in Hsinchu County to encourage high-tech industry. The park has more than 1,500 developed acres and is close to the international airport and harbors, two national universities, and the Industrial Technology Research Institute (ITRI). In 1995, 170 firms operated there, including 51 semiconductor, 39 PC/peripheral, 30 telecommunication, 25 optoelectronic, 16 precision machinery, and 9 biotechnology firms. Of these enterprises, 25 percent were foreign owned.

Batam, Indonesia, and Penang, Malaysia, provide perspectives on two local economies for which the electronics industry has played a significant role in jobs and export earnings, drawing the attention of their national governments. Both islands have aggressively recruited electronics manufacturers for more than 20 years and boast multinational companies, such as Epson, Seagate Technology, and Sony, as tenants. The two islands also have their differences:

Batam has 342 foreign-owned electronics companies and 300 domestic ones that make up approximately 54 percent of all industry on the island (73 percent of Batam's export value). These companies consist mostly of PCB and other back-end assembly plants, producing for multinational companies such as ABB, Siemens, Sumitomo, and Matsushita. Batam officials report that the electronics assembly industry does not produce a substantial amount of the industrial waste on Batam.[48]

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nesian manufacturers, and thirty support companies. The Bandung High Tech Valley would include a graduate engineering exchange program with leading universities overseas, a hi-tech park, venture capital supports, ten multinational corporations, five established Indonesian firms, and twenty start-up companies.

48 Aritenang (1999). According to the Batam Industrial Development Authority, most of the environmental problems facing Batam are indirectly related to industry, because they are mainly caused by unhealthy living conditions. One such problem is squatter settlements, which are located on steep hills and near water reservoirs and create potential dangers for general safety, fires, and water pollution.

In comparison, the Penang Economic Council's Strategic Development Plan was formulated in 1991 to promote skill-intensive, technology-intensive, value-added industries and shift Malaysia's manufacturing competency from labor-intensive to capital-intensive manufacturing.[49] As such, Penang's electronics industry currently produces advanced electronics products and components (electronics tenants include such companies as Intel, AMD, Dell, and Acer), which account for most of the hazardous waste in Penang.[50] Electronics factories in Penang have grown in number from 17 in 1975 to 162 in 1998 and employ 60.4 percent or 118,000 of Penang's workforce. Taiwan is the largest investor there, followed by Japan, the United States, and Singapore.

One specialized industrial estate is Kulim Hi-Tech Park Phase II in Kedah, Malaysia, which specializes in wafer fabrication, memory chips, hard-disk drives, high definition displays, and related products. Eight of Malaysia's eleven designated free-trade zones are devoted to electronics.[51] The Malaysian government has also grouped information technology and electronics industries into specialized areas such as Penang and Johor.

The construction boom continues. Malaysia's newest swatch of electronics and high-tech–related land is the Multimedia Super Corridor—a 15- by 50-kilometer corridor stretching from Kuala Lumpur City Center to Kuala Lumpur International Airport.[52]

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[49] Government of Malaysia (1999).

[50] In Malaysia, hazardous wastes are called "scheduled" wastes and are regulated under the Department of Environment's "Environmental Quality (Scheduled Wastes) Regulation" of 1989.

[51] Boulton and Kelly (1997).

[52] According to Dr. Pola Singh (Aug. 11, 1999), "The Government [also] offers a Bill of Guarantees that includes exemption from local ownership requirements, unrestricted employment of foreign knowledge workers, and the eligibility to tender for key Multimedia Super Corridor (MSC) contracts. Companies with MSC status are also allowed to operate tax free for up to 10 years or granted a 100 percent investment tax allowance. In addition, these companies are exempted from the selective exchange control measures introduced in September 1998. To qualify for MSC status, companies have to be a provider or heavy user of multimedia products and services, employ a substantial number of knowledge workers, and be able

The Multimedia Super Corridor boasts tenants such as Microsoft, NTT, and Lucent Technologies and will cost $20 billion before its completion in 2020. Parallel efforts in Malaysia also include development of the "intelligent cities" of Putrajaya and Cyberjaya.

Singapore has dedicated a 434-acre (174-hectare) industrial area named "Science Hub" to support its electronics industry. The parcel of land is scheduled for completion in 2013 and will host tenants including Dell, National University of Singapore, and Singapore Polytechnic.[53] This is in addition to the existing Woodland Industrial Park, which is solely dedicated to wafer fabs.

Hong Kong is also preparing to counter the move of businesses that have matured and moved into China. In an effort to provide electronics and information technology companies a better technological base, the Hong Kong government has announced the building of a "Cyberport." The site will offer prime residential and office space for services and marketing of the information technology and electronics industries and will occupy 64 acres (25.6 hectares) on the western end of Hong Kong Island at the cost of US$1.6 billion. Cyberport, however, will also include 128,000 square meters of industrial space that will include multimedia laboratories and cyber-related classrooms. At completion, around 2,000 major tenants will include Hewlett-Packard, Hua Wei, IBM, Intel, Microsoft, Oracle, Softbank, Sun Microsystems, Sybase, and Yahoo! These companies will use their Hong Kong location to provide service and administrative functions throughout their Asia-Pacific operations.[54]

Asia presents some unique opportunities to pursue sector-based environmental policy. In fact, its industrial planners are placed

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to transfer technology to Malaysia. As of December 1998, 195 companies were granted MSC status."

53 "High-Technology Starter Homes." *International Herald Tribune*. April 6, 1999. Business/Finance Section..

54 *Op. cit.*

highly enough with sufficient resources on hand to facilitate much of the necessary interaction with industry that was first described in chapter one's Dutch example. Industrial planners not only have the opportunity to have discussions with a burgeoning civil society and NGO community, but they already use industrial estates and other such "places" to organize industry sectors by geographic clusters. This phenomenon, thus, moves the discussion from the "sector-based" model discussed at the beginning of this book to an even more rigorous "cluster-based" model," that accounts both for industry sector and industry location. As policymakers in Asia evaluate whether or not to use this model to improve environmental performance, they still will need to decide how to prioritize their next steps and will need to begin to think about public officials who might have a role to play in this new approach. These issues are the subject of chapters four and five, respectively.

CHAPTER 4:

IDENTIFYING KEY POLICY INTERVENTIONS

As chapter three demonstrated, it is helpful understand how industrial policy develops—who decides, at what level of government, and through what process. In addition to industrial planning, part of the job of public policymakers—both elected and unelected—also frequently includes responding to certain outside motivators or "drivers." One driver already discussed in chapter three is the pressure brought to bear by groups in civil society, which demand leadership from government officials in assuring industries' responsible environmental performance.

This chapter identifies another set of drivers—intermediate processes already under way to address a problem in which governments are expected to participate and show leadership. These processes are particularly important because by definition, they also correspond to possible points for key policy interventions. (The intervention is not the act of participating in the intermediate process per se, but rather the act of fixing the problem.) Chapter four identifies five such processes: *(a)* industrial environmental performance measurement, *(b)* international market requirements, *(c)* international agreements, *(d)* bilateral agreements, and *(e)* public-private partnerships. By paying attention to these five drivers in particular, public officials will be able to assess and improve, respectively, *(a)* the value placed on environmental behavior, *(b)* environmental management systems, *(c)* specific emissions goals, *(d)* waste treatment and disposal, and *(e)* "beyond compliance" performance.

Industrial Environmental Performance Measurements

Asking a public official how well his or her national industries are performing with respect to energy efficiency, materials in-

take, pollution emissions, or other environmental goals sends a strong signal that these measurements are important. Recognizing the importance of accurate measurement and constant improvement, officials from eleven Asia-Pacific Economic Cooperation Forum (APEC) economies participated in a 1997–98 study to evaluate the measurement systems in use by industry sectors in their own countries. Three of the economies—Singapore, Japan, and the United States—chose to include the electronics industry in their studies and produced papers describing currently utilized measurement systems, as well as suggestions for measurement systems that might be more useful in the future.

The Dutch covenant system requires companies to measure and report their progress, and many other corporations already do this on an internal basis for their own use. Might there be lessons to be learned from corporate families that already have made use of environmental measurement systems? Intel develops its corporate environmental policies through the use of "teams" consisting of experts who specialize in materials handling, logistics, environmental management, and so on. Many of these staff members have prior professional experience in government environmental agencies, and they partner with consulting groups to stay abreast of current environmental information. Company officials say that if public officials wanted to copy the policy development successes of a private corporation, one crucial element would need to be an auditing system that accurately indicates the current environmental performance level.

Motorola makes a similar suggestion and notes that, in addition to benchmarking current efforts for use as a baseline, one must then use the measurement systems to track and maintain constant improvement. For any new environmental policy to achieve success, Motorola says its corporate headquarters goes through a process that relies heavily on measurement systems:

- Releasing a public document through the chief operating officer's office
- Assigning responsibility for its implementation to specific sites

- Enforcing the policy through management systems ("carrots" might include recognition or financial rewards, and a "stick" might be a slow track to promotion)
- Measuring progress through internal EHS audits (conducted by peers from other sites)
- Reporting the results by site to the board of directors.

Measurement techniques have one key difference, however. Corporations, largely for internal management purposes, will benchmark and normalize their data (raw numerators expressed per unit of production or value), whereas many national and local governments still set environmental goals and measure progress in ambient terms (raw numerators).

International Market Requirements

The international marketplace is a competitive arena that demands good products and services delivered efficiently, in a timely manner, and at low cost. More and more consumers, investors, and corporate managers are defining a good product as one that is managed in an environmentally responsible manner from the beginning to the end of its life cycle.

ISO 14000 certification is one achievement highly valued by the international market and provides some indication of environmentally responsible management within a facility. The government in Taiwan recognizes this value and is supporting the use of ISO certification and rewards good actors that have received ISO certification with lower insurance rates and streamlined permitting, among others. This type of action is crucial to the semiconductor industry, for which the prompt issue of permits is a competitive issue. Most governments in the world do not reward their ISO-certified companies in this way.

International Agreements

International agreements are also examples of drivers that apply pressure to national governments. They signal issues of interest to the international community and put national governments in the position of having publicly to support or not support the

content of the agreement. In fact, even private companies such as Motorola and Intel report that they have staff dedicated to monitoring international agreements and regulatory trends that set environmental goals and standards. The companies place significant value on these agreements in setting their own corporate policies. This section focuses on international agreements to reduce greenhouse gases.

One example of an international agreement that has produced an industry sector response is the December 1997 Kyoto Protocol. Signed by more than 150 nations, it establishes "binding targets for reducing greenhouse gases, but [also] allows each country to determine its own strategy to meet these targets."[55] On April 23, 1999, the semiconductor industry for the first time responded to international calls for progress in this area. The World Semiconductor Council announced a voluntary goal for its members: 10 percent reduction in absolute emissions of the greenhouse gas perfluorocompounds (PFCs)[56] below 1995 levels by the year 2000.[57] This goal is the responsibility of individual associations, although member companies are also free to announce their own emission reduction goals.[58]

The 1987 Montreal Protocol sets a schedule to phase out sub-

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55 USEPA (1999d).

56 USEPA (1999a). Although the scientific community uses PFC to mean "perfluorocarbon," the semiconductor industry broadens the definition to "perfluorocompound" to include compounds such as nitrogen trifluoride (NF_3) and sulfur hexafluoride (SF_6).

57 The World Semiconductor Council (WSC) reached this agreement in Fiuggi, Italy. WSC comprises representatives from semiconductor industry associations in the United States, Japan, Europe, Taiwan, and Korea, and its members produce more than 90 percent of the world's semiconductors. Although the government of Korea has not signed the Kyoto Protocol, the Korean Semiconductor Industry Association, whose members include Samsung Electron Company, Hyundai Electron Company, LG Semicon Company, and Anam Electron Company, has committed to a 10 percent reduction below 1997 levels by the year 2000. The association works closely with the Korean government, equipment suppliers, and manufacturing companies in its program of PFC reduction, using public policy, financial support, a task force team, and a voluntary action plan as key tools.

58 For example, on April 4, 1999, Motorola announced goals to reduce absolute PFC emissions by 50 percent.

stances destructive to the earth's ozone, to which governments have responded. The Government of Hong Kong (1998) enacted the Ozone Layer Protection ordinance in June 1989 to fulfill its obligations under this protocol. Starting in 1989, the government also prohibited local manufacture of eighty-nine substances, including chlorofluorocarbons, halons, methyl chloroform, carbon tetrachloride, methyl bromide, and hydrochlorofluorocarbons associated with the semiconductor manufacturing process. In 1997 the Government of Indonesia also announced a phaseout of chlorofluorocarbons under the Montreal Protocol. The program seems to be working well, supported by the availability of reasonably priced substitutes and the limited number of producers, many of which have access to new technology. The government also established a National Steering Committee and a National Technical Committee for Ozone Layer Protection and Phase Out, whose responsibilities include country program development and design and implementation of sectoral work programs (including the electronics industry).[59]

Even countries that cannot formally participate in some international arenas are aware of the international recognition that results if they make the same public commitments. The Taiwan Semiconductor Industries Association has voluntarily committed itself to a program of Kyoto-like PFC reductions. In January 1999, all fifteen of Taiwan's integrated circuit manufacturing companies signed a memorandum of understanding to decrease PFC emissions. After twenty-four tool suppliers and gas companies expressed interest, the entire coalition signed a memorandum of understanding with the government of Taiwan, whose primary goals were cleaner production and pollution control.[60]

Because not every country is a signatory to the Kyoto and Montreal protocols, other international negotiations and programs continue working toward industrial environmental improvements. One effort under way is voluntary reporting of emissions

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[59] The Government of Indonesia has also responded to Agenda 21—another U.N. program, which moves nations toward greater environmental management and sustainable development.

[60] Chein (1999b).

of the 3,000 greenhouse gases generated by industrial operations. National governments are collecting data from industry, developing an inventory, and reporting it on an annual basis by industry sector, facility, and gas under the U.N. Framework Convention on Climate Change. These baseline emissions data are designed to help governments set more realistic national policies.

Bilateral Agreements

Bilateral agreements between countries tend to focus on specific needs in which one country might have relatively more experience or capacity to address an issue. This section focuses on the need for industrializing countries to provide adequate hazardous waste treatment and disposal sites for their industrial tenants. A number of governments have recently negotiated with the United States on the issue of transboundary transportation of hazardous industrial waste, an indication that their officials need to be making better long-term provisions for environmental infrastructure in their own countries. Every industry manufactures different products and, therefore, produces dissimilar wastes, requiring various types of environmental infrastructure. Governments, both national and local, that are trying to attract specific industries need to be aware of the unique environmental issues and needs, such as for infrastructure, associated with that industry and should build those considerations into the national industrial and environmental planning process described previously.

The multinational corporation Intel provides insights into the environmental infrastructure needs of electronics manufacturers on waste management. The company does business in a number of countries with less advanced waste disposal systems, including Malaysia, the Philippines, and China. In the Asia-Pacific region, the company has found it challenging to locate acceptable waste disposal or recycling facilities. Some of the company's wastes are hazardous, making disposal a particularly troublesome issue. Although facilities for disposal of some of the low-level hazardous wastes exist in some countries, they are rare in number. No recycling or disposal facilities, for example, are appropriate for metal-bearing sludge in any of the developing

country regions where Intel operates. This situation forced a difficult set of choices for Intel, which could have considered any of the following options:

- Dispose of the wastes within the countries of operation in a manner that is legal, but might not be environmentally sound
- Store the wastes on site for the long term, in the hope that the situation will change in the future
- Arrange for export of the wastes to facilities equipped to handle them.

Having quickly eliminated the first possibility for ethical and prudent reasons, the company faced a choice between storage and export for treatment. Because of Intel's emphasis on recycling and sound treatment and disposal, the company chose to store the hazardous waste temporarily until it could be exported, appropriately treated, and disposed of, as necessary. To date, Intel has only been able to find waste treatment providers and facilities in the United States that meet the company's standards. Transporting hazardous waste to the United States, however, is administratively and legally difficult. The United States is not a signatory to the 1987 Basel Convention,[61] which assures that hazardous waste crossing international borders is handled in an environmentally sound manner. Consequently, transporting waste to the United States from countries that have signed the agreement requires drafting and adopting a bilateral agreement. Such an agreement now exists between the United States and Malaysia, for example. This type of bilateral agreement has allowed Intel to use the same waste service suppliers for some international waste as for domestically generated waste. This means that the company has been able to maintain its emphasis on the environmentally sound management of waste.[62]

Some sources report that although Malaysia's hazardous waste facility has operated since 1998, industry has complained of ex-

[61] The Basel Convention, signed in Budapest, Hungary, by 116 nations, is the first global attempt to regulate and monitor from "cradle to grave" all hazardous wastes that are to be shipped across national borders.

[62] Krut (1999).

orbitant tipping fees (user fees) and is reluctant to send waste to the facility.[63] As a result, industry officials say, hazardous waste is being stored in vats, sold overseas for processing, or dumped illegally. The government of Malaysia notes, however, that

> . . . despite the current economic slowdown, there has been no relaxation in the enforcement of environmental regulations. The majority of industries are continuing to send their wastes meant for treatment and disposal to the Bukit Nanas Scheduled Waste Facility. Recycling of certain waste streams is carried out in approved recycling facilities, while some wastes which cannot be recycled within the country are allowed to be sent for recycling overseas under strict observance of the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes.[64]

Some say that having governments provide increased environmental infrastructure, particularly toxic waste treatment options, would be too politically difficult, as communities would take the "not in my backyard" position. This is especially true in densely packed areas such as Metro Manila, Philippines, where much industry is colocated with residential property. The fact remains, however, that facilities continue to produce waste, which can stay on site in storage drums for years at a time.

In the meantime, environmentally sound waste disposal options in Asia are minimal. Developing a sound waste regulatory infrastructure takes time and support from both the country's government and industries. A flexible waste disposal transition that allows countries without sound waste management technologies to utilize regional waste facilities that do use sound waste technologies needs to be developed to support environmentally conscious industries. Asia should consider moving in a direction that supports development of a regulatory infrastructure that allows for the sharing of environmental technology and regional waste disposal options, whereas national governments—with the help of international organizations—must begin to plan for the devel-

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63 Malaysia's hazardous waste facility is one of only a few in Asia and is a privatized venture under Waste Management Inc., which has a 15-year exclusive agreement.

64 Pola Singh (1999).

opment of their own hazardous waste disposal sites.

Currently, the Philippines' Board of Investments (BOI) through its Environmental Unit is conducting a survey of electronics firms to gather information on waste generated. BOI plans to use these data to decide what kinds of additional waste treatment facilities should be built. The activity is part of a clean management study for the Philippine electronics industry undertaken by the United Nations Conference on Trade and Development.

Demand for Public-Private Partnerships

If governments want companies to perform beyond—or even within—compliance, they may want to consider using public-private partnerships. This section discusses partnerships in which the government plays an active, technical advisory role, as well as partnerships in which the government simply provides funding to allow other organizations to mentor smaller private firms. Private sector companies play a crucial role in these partnerships, because their behavior is what ultimately affects the environment and their proximity to the production line makes them much more efficient at identifying opportunities for internal environmental improvement. On the other hand, governments do have an eye on the aggregate picture and can provide expertise or funding where needed.

Governments can contribute to the success of innovative environmental management by:

- Funding and performing research not covered by the private sector
- Funding and supporting industries willing to perform demonstration projects and go public with the results
- Encouraging utilization of the results of such research
- Serving as a technical link between industry and the regulators
- Serving as a focal point for comprehensive, multimedia pollution reduction strategies
- Compiling and distributing information about cost-effective environmental management techniques that do not nega-

tively affect process or product performance.

All of these approaches require partnerships and interaction with industry and are further enhanced by support from NGO and community groups.

USEPA programs. USEPA has long supported public-private partnerships and voluntary programs to reach its national goals in emissions reductions of greenhouse gases and improvements in energy efficiency. Such programs include Greenlights (energy-efficient lighting fixtures); Energy Star Buildings (including the Energy Star label cosponsored by the U.S. Department of Energy); voluntary partnerships in the magnesium, aluminum, chemical, cogeneration, and electric utility industries; and the PFC Reduction Partnership under EPA's Climate Protection Division.[65] As part of its "sector-based approach" to environmental protection, this division has targeted the following five priority industries, which have high "global warming potential" because of the greenhouse gases[66] and chemicals that they use or produce: semiconductor manufacturing, magnesium processing, aluminum processing, electric power utilities, and production of hydrochlorofluorocarbons for refrigerants. In the case of semiconductor manufacturing, PFC emissions in the United States have increased sevenfold since 1990.

The PFC Emission Reduction Partnership for the Semiconductor Industry is a voluntary agreement between the semiconductor industry and the U.S. Environmental Protection Agency developed in collaboration with the U.S. Semiconductor Industry As-

[65] See appendix C for more than thirty USEPA public-private sector–based partnerships.

[66] According to USEPA (1996b), "Greenhouse gases are compounds capable of trapping solar radiation in the earth's atmosphere. Greenhouse gases are classified by their estimated atmospheric lifetime and global warming potential relative to the abundant greenhouse gas, carbon dioxide. Of all greenhouse gases, PFCs and several hydrofluorocarbons (HFCs) are the most potent because of their extreme stability in the atmosphere and strong absorption of radiation. PFCs commonly have atmospheric lifetimes on the order of thousands of years; therefore, continuing emissions of these gases will contribute to an existing atmospheric burden. A number of PFCs and HFCs are used in semiconductor manufacturing."

sociation. The agreement is based on the commitment of companies to estimate their PFC emissions beginning in 1995, reduce their emissions of PFCs in both U.S. and non-U.S. operations, as well as "share information about successful PFC emission reduction processes and technologies that the companies consider nonconfidential." This commitment is in exchange for emissions reduction flexibility from USEPA, public recognition, and technical assistance.[67] Each participating company agrees to track and report absolute *and* normalized emissions numbers on an annual basis, based on the belief that if "you cannot measure it, you cannot evaluate or control climate protection."[68] This program enables participants to document their early contributions to preventing global climate change.

PFCs are stable and robust; therefore, although they are considered relatively safe to work with, they persist in the atmosphere and are among the gases with the strongest greenhouse warming potential. PFCs are a rather high-profile substance, because they *(a)* are used by a small number of industry groups, *(b)* are man-made, *(c)* are emitted during industrial processes, and *(d)* have a high global warming potential. The PFC partnership is particularly notable because these gases are not ones regulated under U.S. law.

In the United States, USEPA's Common Sense Initiative (CSI), completed in 1998, represented another innovative, public-private partnership approach to environmental protection and pollution prevention. The initiative addressed environmental management by industrial sector. USEPA selected six industries—representing 12 percent of U.S. GDP, employing more than four million people, and accounting for more than 12 percent of toxic releases reported in the United States—to serve as

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[67] As part of this program, USEPA has also pledged to seek similar commitments from all companies with semiconductor operations in the United States, including foreign-owned companies.

[68] Sally Rand in a presentation entitled "IPCC Good Practice Inventory Methods for PFCs from Semiconductor Manufacture" for the "1999 International Semiconductor Environment, Safety, and Health Conference." U.S. Environmental Protection Agency, June 15, 1999, in Williamsburg, Va.

CSI pilots. These include computers and electronics,[69] automobile manufacturing, iron and steel production, metal finishing, petroleum refining, and printing. Representatives of industry, labor and environmental organizations, USEPA, environmental justice organizations, and state and local governments analyzed environmental issues facing these six industries. These included pollution prevention, environmental reporting requirements, and public access to environmental information.[70]

Box 5. Companies in USEPA's PFC Emission Reduction Partnership

As of January 19, 1999, the twenty-four companies below had joined the USEPA partnership program:

Advanced Micro Devices
American Microsystems
Burr-Brown Corporation
Cherry Semiconductor Corp.
Digital Equipment Corp.
Dominion Semiconductor
Eastman Kodak Company
Hewlett-Packard Company
Hitachi Semiconductor
IBM Corporation
Intel Corporation
LSI Logic Corporation
Lucent Technologies
Micron Technology
Motorola
National Semiconductor Corp.
NEC Electronics
Philips Electronics North American Corporation
Rockwell Semiconductor Systems
Sony Semiconductor Company of America
STMicroelectronics
Symbios Logic
Texas Instruments
VLSI Technology

[69] In the CSI program, "electronics" referred to display technologies (cathode ray tube), semiconductors, and printed circuit boards.

[70] Representatives on the electronics subcommittee included U.S. and state environmental protection agencies, Communication Workers of America, Continental Circuits Corporation, Digital Equipment Corporation, Electronic Industry Association, the Environmental Defense Fund, The Institute for Interconnecting and Packaging Electronic Circuits, Intel Corporation, M/A-COM, National Coalition of Hispanic Health and Human Services Organizations, New Mexico Environmental Law Center, Texas Instru-

CSI subcommittees worked to review rules, streamline permits, consolidate reports, and use innovative technologies to change or evolve traditional practices. CSI resulted in more than forty projects, with almost thirty of its recommendations endorsed by USEPA. Its regulatory efforts included a first-of-its-kind, voluntary, performance-based alternative regulatory system in the metal-finishing industry. It revised hazardous waste regulations under the Resource Conservation and Recovery Act to facilitate cathode ray tube glass-to-glass recycling in the computer and electronics sector. It amended air regulations for particulate emissions monitoring from electric arc furnaces in the iron and steel industry.

Corporate mentoring of SMEs. Small and medium enterprises tend to put less emphasis on environmental performance, citing primarily economic reasons. Some believe it is mostly the responsibility of large multinational corporations, but also national governments and resource-rich organizations, to act as environmental "champions," imparting the lessons they have already learned to their employees, suppliers, and partners, thereby paving the way for SMEs.

Hong Kong has a large segment of industrial production that comes from SMEs. Due to SMEs' limited technical and financial capabilities to implement environmental measures, they are comparatively less active in environmental programs. This situation is compounded by the fact that many SMEs do not currently feel regulatory pressure; their sheer number makes it difficult for regulatory agencies to identify, monitor, and penalize SME polluters. A 1993 survey conducted by the Hong Kong Productivity Council (HKPC) revealed that most PCB factories surveyed had not installed wastewater treatment systems and were smaller PCB manufacturing facilities located on upper floors of industrial buildings. As such, these factories were limited by spatial constraints from installing treatment systems for high volumes of

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ments, Santa Clara Country Pollution Prevention Program, Silicon Valley Toxics Coalition, University of Massachusetts, and the World Resources Institute.

complex wastewater. The small percentage that did have systems installed were exclusively large-scale operations supplying their products to multinational corporations.[71]

In an attempt to replicate and multiply the more stringent environmental initiatives undertaken when a company becomes part of a global supply chain, HKPC began a program in August 1999 with funding from the Hong Kong Industry Department for PCB manufacturers and other SMEs to "green the supply chain." The program is essentially a management approach that enables formation of partnerships among industrial organizations to achieve specific cleaner production goals. It involves three parties: *(a)* mentor firms that have demonstrated good environmental performance, *(b)* participating SMEs that are suppliers or contractors to the mentor firms, and *(c)* HKPC staff working as consultants to provide professional assistance in cleaner production. Under the leadership of large companies (the mentor firms), suppliers are organized to work together to achieve certain cleaner production goals common to each other and each participating firm is provided with technical assistance in cleaner production.

Housekeeping and process improvements are both important aspects of this program. Additionally, because many Hong Kong companies have moved their production across the border into mainland China, HKPC's mentoring program may naturally extend there too, especially in regard to water issues. HKPC hopes for participation by about five mentor firms and twenty to twenty-five SMEs. Critics of the program believe that the number of participating SMEs is too small to have much of an impact.

Taiwan's ITRI has had a similar program functioning for 20 years. The funding structure is similar, but ITRI has more than 6,000 staff available to help. Among its participating companies, ITRI emphasizes the need for continued cooperation with Tai-

[71] Government of Hong Kong (1995a). Likewise, officials in the Philippines have noted that "While most of the multinational companies of this sector have wastewater treatment facilities, the common waste disposal practice of SMEs is to discharge wastewater directly into the drainage system" (Cariño, 1998).

wan EPA and insists on regulatory compliance as a primary goal. The Government of Malaysia also facilitates corporate environmental mentoring programs.

Governments themselves can also benefit from technical assistance provided by private corporations in partnership programs. On its own initiative, Motorola committed itself to working with 500 of China's state-owned enterprises in a mentoring program, which began in China three years ago. This is part of an effort to grow the company's long-term pool of available suppliers. The development of "transnational standards" (internal company policies harmonized across national borders) is a growing and important trend, as these standards tend to be more stringent than national regulations and entire sectors are congregating around these norms.

Environmental performance measurement, international markets, bilateral agreements, and partnerships involve processes in which governments participate or which are sometimes thrust on them. In either case, these processes provide insight into the environmental problems that governments may want to address as part of their work in general, as well as part of the development of a cluster-based model. Chapter five discusses some preliminary recommendations for such a model.

CHAPTER 5:

PRELIMINARY RECOMMENDATIONS FOR A REGIONAL POLICY MODEL

As seen in chapter two, governments have begun using bits and pieces of a new approach to improving industrial environmental performance. This approach incorporates the core regulatory functions that all governments must still perform. At the same time, however:

- It is multimedia in nature (simultaneously addressing air, water, and waste issues)
- Its process is nonprescriptive (flexible and voluntary to implement), farsighted, and inclusive of stakeholders
- It assigns responsibility for sustainable development across government agencies.

Chapter three showed that Asian industry is often formally clustered into industrial estates. When the sector-based approach is implemented in specific locations—such as industrial estates—and when it takes into consideration the special needs and strengths of local suppliers, business partners, competing firms, and customers, this approach is more appropriately termed "cluster based." Throughout this document, the authors use the term "cluster-based approaches" to indicate those sector-based approaches that government officials intend to implement in industry clusters. As defined in chapter three, these are groups of firms in similar and related industries that do business with each other and share needs for common talent, technology, and infrastructure and, therefore, have a common interest in locating near one another.

It is clear from chapter four, however, that many more opportunities are available to integrate this cluster-based approach into the industrial planning process. The authors have identified some

drivers and points of intervention that might help public officials to map a course of action. This chapter builds on these ideas by outlining possible roles for policymakers interested in pursuing a cluster-based environmental approach.

Enough localities worldwide have adopted cluster-based strategies to demonstrate fully the steps involved in cluster analysis and implementation. Many geographic locations in Asia already emphasize certain industrial sectors, such as Batam, Indonesia; Penang, Malaysia; Woodlands Industrial Park in Singapore; and Hsinchu Science Park in Taiwan. The steps needed for any one country in the region to analyze and implement cluster-based approaches, therefore, would be relatively easy to design based on others' experience. Perhaps industrial enclaves on the "silicon islands" would be a good place to start implementation of a pilot cluster-based program. Briefly, the steps would involve the following:

- Identify important industry clusters that are prevalent in the Asia-Pacific region and will benefit from cluster-based approaches to environmental policy. (Economies of scale exist for identifying clusters in several countries at once, especially when a number of big companies have sites across the region.)
- Conduct a cluster analysis (see box 4 on page 39), in part by drawing a "cluster map" showing the three key components of the cluster: export-oriented sectors, support services, and specialized infrastructure (such as research institutions and industry parks).
- Identify key stakeholders in the cluster's success. Mapping clusters will help to identify key stakeholders in each of the three components.
- Form a leadership group comprising recognized company leaders, key government officials, and others critical to the cluster's success. This group should sponsor the overall process, empower cluster work groups, receive results from the work groups, and decide how to support implementation.
- Form a cluster work group that is cochaired by representatives from the public and private sector and includes repre-

sentatives from each of the component industries of the cluster. The chairpersons and members should come from a combination of large and small businesses, product and service sectors, business, government, and education. Participants should also be selected for how they will help the process succeed—based on their stature, entrepreneurial drive, and so on.

- Facilitate three or four working group meetings designed to personally involve key cluster leaders in identifying significant environmental and competitiveness issues, developing potential solutions, and building support for their initiatives.
- Report initiatives and action steps to the leadership group.
- Have the leadership group and cluster group design an action plan and continue to facilitate and support it.
- Keep the focus on strengthening regional and industry competitiveness.
- Facilitate collaboration for successful problem solving, because negotiation, an important part of the process, seldom happens spontaneously.

Concerns and Solutions Related to Sector-Based Planning

As with any new public policy approach, the reality in which policymakers must implement the cluster-based program will determine its success or failure. Already, several challenges to the cluster-based approach have become apparent, for instance:

- Environmental agencies may believe other government agencies are encroaching on their areas of responsibilities.
- Other agencies that have committed themselves to building a cluster-based environmental approach into their planning activities may be understaffed, without experienced leadership, and underfinanced in this area and may feel overwhelmed by the prospect as well.
- Private sector participants, sensing these same pressures, may hesitate to get involved.
- It may be difficult to measure progress toward success without some careful planning up front.

Some organizations that have already analyzed the cluster-based process provide below some ideas for possible solutions:

Interagency assistance. Unlike in the United States or Europe, many environmental ministries in Asia are relatively weak in terms of staff, budget, and authority. Boards of investment and ministries of industry in those same countries, however, are well positioned to help, as many of them have special divisions that also focus on the environment. For example, a ministry of industry might have an environment division, although its responsibility is usually advisory, such as providing environment-related information to prospective investors.

Increasingly, however, these environmental divisions should (and do) undertake a more proactive and aggressive role, such as helping to set and implement national environmental goals. For instance, Department of Trade and Industry officials in the Philippines say the department views the environment as a tool in national competitiveness building and BOI has already formed its own environmental unit, which has undertaken a study of the industrial waste treatment needs in Metro Manila. Likewise, Indonesia's Directorate for the Electronics Industry in the Ministry of Industry and Trade offers a program to industries that have committed themselves to meeting ozone-depleting substance (ODS) targets. The program includes suggestions for chemical substitutes, alternative technologies or production processes, recycling or retrofit programs, or premature retirement of production lines. The directorate further assists industry by providing investment policies to encourage introduction of safe alternative technologies, a framework for inspection and monitoring of ODS phaseout, appropriate taxing and credit policies intended to maintain the momentum of phase-out rate, a ban on the creation of added manufacturing capacity using ODS, and a policy intended to compensate those industries that will be closed down.[72]

For a cluster-based approach to be implemented successfully, each government ministry should have more responsibility for

[72] Munaf (1999).

environment-related matters, whether it be supplementing environmental regulations with industry covenants, setting goals for unregulated issues, or providing or financing appropriate environmental infrastructure.

Of course, one problem may be the extent to which the central environmental agency is willing to share its interests with another agency. More open lines of communication among the different government agencies is a prerequisite for success. Legislation or a memorandum of understanding may even be needed among government ministries. This should detail administrative procedures, such as who has domain and over what. As part of the process, environment ministries must allow for the sharing of duties among and across the other ministries. It would have to be made clear to each environmental ministry, however, that its authority is in no way diminished. In fact, some of the most innovative work involving ministries of industry and other stakeholders has been led by the environmental agencies themselves. The purpose of this new cluster-based approach would be to improve the overall environmental performance of industry, which is a widely shared goal.

Institutional capacity and program logistics. The Dutch maintain that an increased, trained, and devoted government staff is a crucial element to the success of a negotiated covenant system (a cluster-based approach, for our purposes). Yet, the Asian economic crisis resulted in across-the-board budget cuts in the public sector, which have seriously hampered the ability of environmental ministries to take "full" responsibility for industrial environmental performance.

Government and private sector officials interested in pursuing cluster-based policy may feel some trepidation about their own institutional capacity to think innovatively, implement effectively, and still carry out their fundamental duties. From the private sector side, one of the biggest challenges at the outset is to ensure that all three types of cluster participants—export-oriented sectors, support sectors, and specialized community infrastructure—are involved in the process, including SMEs. Once

identified as participants, the second challenge relating to companies is the ability to meet targets or comply with standards.
Any model developed for use in the Asia-Pacific region must adopt a realistic stance on SMEs, evaluating their capacity and resources. Effective cluster-based planning should theoretically reach even the smallest facility. Led by the largest companies, a cluster-based model would eventually affect the entire industry. The model, therefore, will need to incorporate and consider trickle-down programs, also known as corporate mentoring programs, including additional training and education. Other motivators for SMEs could come through pressure from their customers and major buyers, product labeling programs, and public service announcements.

On the government side, regulatory agencies must continue to strengthen the effectiveness of regulatory institutions—the foundation on which a cluster-based system is built. Simultaneously, environmental and industrial officials should be continuing a learning process to shore up their institutional capabilities to deal with increasingly complex environmental problems.

Part of the process also involves documenting and tracking the success of the cluster-based approach. This is a difficult task. It is challenging to quantify the overall impact of the environmental project and program in terms of benefits to the community. Currently, the correlation between sector-based public policies and related environmental impacts is pretty loosely documented. The Dutch have published cost savings numbers of 20 to 50 percent in regulatory actions. So have U.S. officials, who say they have saved about 27 million hours each year on paperwork because of the agency's innovative efforts, including sector-based programs. One crucial element to any environmental policy development is an internal auditing system that accurately indicates not only current environmental performance levels, but also has the ability to track progress over time.

Ownership and leadership. The idea for a cluster-based approach in Asia will have to be vetted to and accepted by a top-level ministry. It will need to be marketed thoughtfully with case

studies of success stories and innovations. To move forward, government ministries must be convinced of the strategic importance of the approach and should be led by one "champion," a key government ministry such as the ministry of science, technology, and environment or equivalent. Problem-solving leadership must involve not only public decisionmakers, but also the private sector and community. Public officials should remember to engage business leaders rather than "consulting" with them to build their commitment. This approach has a better chance of succeeding if directors of all these organizations publicly announce their support and participation in the process, assign responsibility for its implementation, enforce the policy, and measure and report progress.

For their part, private sector participants need to remember that the goal of the cluster-based process is to identify and build on the "enlightened self-interest" of companies. The process means neither charity, nor command and control. Financial incentives help get stakeholders to the table, but should be a condition of collaboration and joint problem solving (e.g., in Arizona only cluster organizations that partner with school districts can apply for job training and school-to-work grants).

Organizations searching for resources for ideas, training, and capacity building could call on universities, governments, and other experts that already have cluster-based experience, for example, officials at Arizona State University who helped with Arizona's cluster-based work, public environmental officials from the states of Florida and Wisconsin who are conducting their own sector-based regulatory work, and the Office of Reinvention at USEPA. As previously mentioned, the sister-state relationship that Wisconsin has with the Federal Republic of Bavaria provides a good cache of ideas, as both locales try to grow their industries in an environmentally responsible manner.

Next Steps

Unlike "place-based" public policies in Asia, which focus on tangible entities with physical boundaries (i.e., lake basins, industrial estates, regional growth triangles), "sector-based" public

policies are a more challenging concept to implement. It helps to

Box 6. Possible Roles for Public Policy Officials in Cluster-Based Environmental Policy

Chapters two through five have sketched out already existing programs that use cluster-based approaches to environmental improvement. The outline below captures those programs and identifies where in a government structure they might originate. Clearly, substantial roles are available for government officials with many different levels of seniority and specialty.

I. Executive advisors to the head of state
II. Ministries/departments of trade and industry or economics and related research bodies:
    A. Including sustainable development policy in national development plans
    B. Attracting industry
    C. Targeting economic incentives
    D. Developing acceptable environmental infrastructure
    E. Paying attention to environmental signals
    F. Voluntary partnerships for PFC and other greenhouse gas emission reductions
    G. Greening the supply chain/corporate mentoring with public support
II. Ministry of Land Planning
    A. Industrial growth planning
III. Ministries/Departments of Environment
    A. Declaration of national sustainable development policy
    B. Core regulatory functions:
        1. Regulations
        2. Take-back laws
        3. Permitting
        4. Compliance assistance
IV. Ministries/departments of finance
    A. Getting financing right
V. Ministry of education and other human resource organizations
VI. Related officials at the state and local levels.

tie the "place-based" and "sector-based concepts under the more inclusive term of "cluster-based" environmental activities, first, because the importance of pursuing the industry sector as a public policy model has become clear and, second, because Asian governments already successfully use a structured, place-based approach to industrial development.

The environment increasingly has become a strategic, competitive good in the eyes of public officials and investors. In fact, in September 1999, Dow Jones announced a new "sustainability index" in the belief that the environment is now proven [as] an "investable concept." Assigning full responsibility for its care to the oftentimes weak environmental agencies in Asia makes little sense. The Philippine BOI not only says the environment is an important aspect of business, but has created its own environmental unit to begin to address many environmental problems faced or caused by industry. In fact, many ministries of trade, industry, or finance are establishing their own environmental units. But what is the most effective use of these units? Where can they play a leadership role in environmental improvement? One answer may lie in the cluster-based policy model. Box 6 above outlines possible roles for public policymakers in pursuit of such an approach.

Those government officials who decide to move forward with the cluster-based concept may want to commission a position paper that develops a cluster-based plan geared to the strength of Asia's public policy culture and industrial planning process. This plan could then be presented to a government ministry in the region for consideration and adoption into the national planning process itself.

APPENDIX A:

THE ELECTRONICS INDUSTRY IN THE ASIA-PACIFIC REGION

The authors of this report chose to highlight aspects of burgeoning electronics production across the Asia-Pacific region, because the industry is a high-profile, high-profit sector representing a significant percentage of national GDP and export value. This dynamic industry leads much of the economic growth across the region and serves as a common frame of reference, to which many public officials responsible for R&D, production, trade, and regulation oversight can relate. Asia's electronics production involves investors from around the globe, multinational (transnational) corporations, and domestically owned enterprises.

The electronics industry is broadly representative of other industries to which sector-based approaches may be applied. The industry demonstrates a range of activities (from low-end assembly operations to high-tech R&D), generates revenue in both the export and domestic markets, benefits from intentional policy planning at the highest levels, and gets involved in partnerships with government, suppliers, and NGOs to grapple with issues of sustainable development. The industry also enjoys fast growth and so could provide a useful "proving ground" for the sector-based opportunities discussed in this report. Any pilot projects would quickly prove or disprove their merit.

Composition of the Electronics Industry

Facilities in the electronics sector manufacture an extensive range of consumer products—cellular telephones, computers, fax machines, televisions, and CD players—that include such electronic components as semiconductors, PCBs, display technology (cathode ray tubes and flat panel displays), batteries, transformers, and generators. This report focuses on two of the primary electronics subindustries—semiconductors and printed circuit boards—as the most prominent segments of the industry and the ones confronted with the most serious environmental challenges

Semiconductors. According to Bartos and Burton (1999), semiconductors serve as the brains in advanced electronic controls and devices and have in recent years become increasingly prevalent in consumer and industrial equipment. Semiconductors can act either as conductors by guiding or moving an electrical current or as insulators by preventing

the passage of heat or electricity. They are usually made of silicone and formed into a simple diode or many integrated circuits. A simple diode is an individual circuit that performs a single function affecting the flow of electrical current. Integrated circuits combine two or more diodes. Up to several thousand integrated circuits can be formed on the wafer (a thin slice of semiconductor [as silicon] used as a base for an electronic component or circuit), although 200–300 integrated circuits are usually formed. The area on the wafer occupied by integrated circuits is called a chip or die. The semiconductor manufacturing process involves five steps: design, crystal processing, wafer fabrication, final layering and cleaning, and assembly.[73]

In the semiconductor sector, assembly and product testing are the labor-intensive and wafer design and fabrication are the capital-intensive segments of the production process. Semiconductors are produced by approximately 400 organizations around the world in 1,100 fabs (semiconductor [wafer] fabrication facilities).[74]

Printed circuit boards. Printed circuit boards (PCBs) are the physical structures on which semiconductors are mounted. Terminology differs by region: U.S. manufacturers tend to use the term "printed wiring board," whereas other manufacturers use the term PCB. The PCB fabrication industry is driven by the computer and telecommunication sectors, which consume roughly 60 percent of PCB production. Printed wiring boards can be single sided with a conductive pattern on one side only, double sided with conductive patterns on both faces, multilayer,[75] or flexible boards. The manufacturing process includes five steps: board cleaning and surface preparation, catalyst application of conducting coatings (plating), pattern printing and masking, electroplating, and etching.[76]

Environmental Issues

Despite heavy reliance on Asia's electronics manufacturers to meet established national economic goals, public and private leaders are well aware of the environmental issues associated with management, manu-

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[73] Bartos and Burton (1999); Krut (1999); USEPA (1995a); and Chiang (1998) on PCBs.

[74] Bartos and Burton (1999).

[75] According to the Government of Hong Kong (1995a), multilayer boards consist of alternating layers of conductor and insulating material pressed and laminated together. Conductors on different layers are linked through plated-through holes.

[76] USEPA (1995a) and Government of Hong Kong (1995a).

facturing, and disposal processes of electronics firms. These issues affect factory workers, local communities, and consumers.

Management. Across the region, a consulting industry has sprung up to support the environmental, health, and safety needs of the electronics industry. Many of these efforts are a response to 1996 factory fires that devastated two semiconductor fabs (owned by Taiwan's Winbond Electronics Corporation and United Microelectronics Corporation) in Taiwan's Hsinchu Science Park, which resulted in more than $500 million in losses. The tragedies happened partly because of a lack of proper facility start-up procedures (i.e., beginning operations without first installing the proper water and sprinkler systems). Local municipal authorities, for their part, had only one small fire station at the park, which did not have enough high-pressure water hookups, proper equipment, or adequately trained staff available to save the factories.[77] Despite greater attention to safety procedures on a facility basis, critics still contend that Taiwan's massive fab buildup in recent years looks like a disaster waiting to happen. Hsinchu Science Park, they say, is just too densely cluttered.

Manufacturing. The building blocks of this industry, including semiconductors and printed circuit boards, have typically been considered relatively "clean" in terms of environmental impact, compared with other industry sectors. The U.S. electronics industry only emits 1.6 percent of total U.S. Toxic Release Inventory emissions annually.[78]

"In spite of its 'clean room' image, however, electronic component manufacturers—like the chemical sector—employ highly toxic, hazardous substances with significant potential risks for human health and the environment." [79] (See appendix C for a list of chemicals.) Several groups, including the Hong Kong government, European Electronic Component Manufacturers Association, Lucent Technologies, and Xerox Corporation are compiling data bases of international regulations that limit or ban the use of chemicals used in the semiconductor industry to harmonize corporate and public policies across borders and facilitate transparent operations.

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77 One series of calamities that has resulted in voluntary codes of conduct and self-improvement within a single industry is the 1996 fires in toy factories throughout China and Hong Kong.

78 Krut (1999).

79 Tomorrow Publishing AB (1999b).

One of the primary obstacles to high-quality semiconductor production is contamination, particularly dust on the circuit path. A "clean" production environment, therefore, is essential. Cleaning operations precede and follow many of the manufacturing process steps. Wet processing, during which semiconductor devices are repeatedly dipped, immersed, or sprayed with solutions, is commonly used to minimize the risk of contamination. "Sulfuric acid and hydrochloric acid, two of the most commonly released chemicals, are used during etching and cleaning processes. Solvents such as acetone, glycol ethers, xylene, and freon 113 are used during photolithography and cleaning. A significant amount of methyl ethyl ketone is released during the degreasing and cleaning process."[80] Environmental issues connected with the PCB manufacturing process also include chemical waste (from used etchants with high levels of copper, spent dry film developers, spent resist strips, and used solvents), large volumes of wastewater (with high or low pH and containing heavy metals and toxic solvents), air pollution (from fumes related to etching solutions, solvents, and photoresist developers).

Waste disposal. The electronics industry generates both solid and liquid wastes that are toxic and hazardous. Solid wastes consist of metal scraps, empty chemical containers and sludges, whereas liquid wastes include spent process solutions such as plating solution, degreasers, rinse water, and floor washings.

In the United States, inadequate wastewater disposal protocol from the early days of production in Silicon Valley has resulted in contamination of once pristine groundwater and drinking water reservoirs. The greatest concentration of hazardous waste cleanup sites in the country occurs in Silicon Valley. Much of the region's groundwater has become severely contaminated.[81] As a result, several lawsuits have been filed, including in Santa Clara County, the heart of Silicon Valley. Dozens of plaintiffs claim they developed cancer from drinking water contaminated by improperly treated industrial waste.[82]

In fact, the news media is increasingly demanding epidemiological studies on cancer and birth defects related to the semiconductor industry because of the high potential for endocrine disrupters.[83] Many of

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80 USEPA (1995a).

81 Tomorrow Publishing AB (1999b).

82 Schmidt (1998).

83 See <www.svtc.org> and also the Environmental Defense Fund's <www.scorecard.org> for more information.

these calls for research are coming from Silicon Valley Toxics Coalition, "which was formed [in 1982] in response to the discovery of substantial groundwater contamination in Silicon Valley caused by a leaking underground storage tank at a semiconductor plant. In June 1996 the coalition published its draft Silicon Principles dealing with global environment, health, and safety management and asked the high-tech industry to endorse them"[84]

Needless to say, localities in the Asia-Pacific region that have expressed goals of becoming the next "Silicon Valley" are referring to the location's economic successes and not environmental failures. Government officials in Asia are paying close attention to public policies and disposal techniques that will prevent such contamination in their own communities.

[84] Krut (1999).

APPENDIX B:

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Dr. Pola is responsible for the planning of the industrial sector in Malaysia, in terms of formulating policy directions, programs, and strategies for industries including electronics. He has served in the Malaysian government for the past 27 years and holds a doctoral degree in marketing and a master's degree in business administration from the University of Alabama in Tuscaloosa.

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Ms. Vicars has worked in environmentally related jobs for more than 15 years. Prior to working at Intel, she managed chemical and hazardous waste management in the United States for a large multinational semiconductor company and now manages the worldwide hazardous material transportation program at Intel. Earlier this year, Lynda participated in the Third Philippine International Toxic and Hazardous Waste Congress and supports her international sites by interacting with government agencies in developing environmentally sound waste recycling and disposal opportunities. Lynda has a bachelor's degree in biological sciences with a minor in chemistry, and a master's degree in genetic toxicology.

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Ms. Waits' areas of expertise include economic development, urban growth, environment, and crime prevention and she has been involved in the development and analysis of environmental and economic policy for more than 20 years. She was one of three leaders of the consultant team for the multiyear Arizona Strategic Plan for Economic Development project. Ms. Waits' articles on economic development have been published in the 1998 publication *Handbook of Economic Development*, as well as in *Public Administration Review*, *Economic Development Quarterly,* and *Economic Development Commentary.* She was assistant director for the Arizona Governor's Office of Policy Development and Planning during the Babbitt Administration and also served as a senior economic policy advisor to the governor and lieutenant governor of Alaska, providing organization and land-use assistance. She is an executive board member of the Governor's Strategic Partnership for Economic Development and a member of the North American Development Bank's Advisory Board, appointed by President Clinton. Ms. Waits holds a master's degree in public administration from the University of Southern California.

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APPENDIX C:

SECTOR-BASED PROGRAMS IN USEPA

USEPA uses a broad definition of an industry sector as a "discrete production and supplier system in the U.S. economy." More than half of USEPA's thirty-one Partnership Programs focus on specific industry sectors, and nearly half of its Regional Programs similarly focus on industry sectors.[85] USEPA's sector approach specifically involves multiple stakeholders, which the agency defines as *(a)* the regulated industries, *(b)* government regulators, *(c)* environmental activists, *(d)* environmental justice groups, and *(e)* labor groups.

Table A on the following pages details USEPA's various sector-based programs.

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[85] USEPA (1999b).

Table 2. Sector-Based Programs in USEPA by National Program Office (Headquarters) and Region as of 12/1998

Program	Sector	Description	Contact Info
Office of Air and Radiation			
1. AgSTAR	Dairy, pork, and other livestock producers (main focus: swine and dairy industries)	Part of the Climate Change Action Plan and USEPA's Partners for the Environment. AgSTAR promotes reduction of methane emissions through manure management and is designed to remove barriers that impede the widespread adoption of technologies that capture and utilize the energy value in agricultural methane. The goal is to reduce U.S. methane emissions by 2.25 million metric tons of carbon equivalent by the year 2000. To achieve this goal, it will be necessary for 2,000 farms to install manure methane recovery systems (approximately 20 percent of the swine industry and 15 percent of the dairy industry).	Kurt Roos, Office of Atmospheric Programs 1-202-564-9041 Roos.kurt@epa.gov www.epa.gov/agstar
2. Coalbed Methane Outreach Program	Coal mining industry	Part of the Climate Change Action Plan and USEPA's Partners for the Environment. The program encourages coal mines to recover and use or sell coal mine methane as an energy source. The program raises awareness of opportunities for profitable investment. The goal of the program is to use technical and economic information to identify and remove obstacles to profitable methane-recovery coal mines.	Karl Schultz, Climate Protection Division 1-202-564-9468 Schultz.Karl@epa.gov www.epa.gov/coalbed
3. Consolidated Federal Air Rule	Chemical manufacturers	Under a consolidated proposed air rule, chemical manufacturers could save 1,700 person-hours or $80,000 per year. The proposal, which represents the first consolidated rule under the Clean Air Act, would be voluntary and could replace the existing sixteen rules. This will be used as a model for consolidating other rules under the Clean Air Act or other statutes in the future.	Rick Colyer, Office of Air Quality Planning and Standards 1-919-541-5262 Colyer.Rick@epa.gov www.epa.gov/reinvent/notebook/cfar
4. Energy Star	Energy-	Part of USEPA's Partners for the Environment. Energy Star optimizes	Scott Thigpen

Program	Sector	Description	Contact Info
	efficient equipment and buildings	energy efficiency and profits, while preventing pollution. The program promotes the purchase and installation of energy-efficient equipment and lighting technology in commercial, industrial, and residential buildings.	1-202-564-9002 Thigpen.Scott@epa.gov www.epa.gov/energystar
5. National Emission Standards for Hazardous Air Pollutants: MACT Rules	Dry cleaning, aerospace, and iron and steel	The maximum achievable control technology (MACT) rules regulate hazardous air pollutants in various source categories as required by the 1990 amendments to the Clean Air Act. Source categories are subdivided in 2-year, 4-year, 7-year, and 10-year "bins."	Yvonne W. Johnson, Office of Air Quality Planning and Standards (OAQPS) 1-919-541-2798 Johnson.YvonneW@epa.gov
6. Landfill Methane Outreach Program (LMOP)	Landfill gas industry, state regulators, electric utilities, power marketers, landfill owners and operators, and communities	Part of the Climate Change Action Plan and USEPA's Partners for the Environment. LMOP works with the landfill gas industry and other stakeholders to facilitate beneficial landfill gas utilization projects. LMOP provides technical and marketing information and assistance to help potential projects overcome barriers to development. Using the landfill gas as an energy resource reduces emissions of a potent greenhouse gas and utilizes a local, renewable source of energy. LMOP links communities with innovative ways to deal with their landfill gas industry through better management.	Shelley Cohen, Office of Atmospheric Programs 1-202-564-9797 Cohen.Shelley@epa.gov www.epa.gov/lmop
7. Natural Gas Star	Natural gas transmitters, distributors,	Part of the Climate Change Action Plan. This voluntary program works closely with the natural gas industry to reduce emissions of methane. It encourages companies to adopt cost-effective best management practices	Paul Gunning, Office of Atmospheric Programs

Program	Sector	Description	Contact Info
	and producers and processors	that reduce leaks and losses of natural gas. It works as an effective technology transfer program for promoting innovative processes and technologies.	1-202-564-9736 Gunning.Paul@epa.gov www.epa.gov/outreach/gasstar
8. Ruminant Livestock Efficiency Program (RLEP)	Beef and dairy producers	Part of the Climate Change Action Plan and USEPA's Partners for the Environment. RLEP is a collaborative effort between USEPA and USDA that promotes reduction of methane emissions from ruminant livestock. The program helps producers voluntarily reduce emissions of methane and other greenhouse gases through management strategies that improve production efficiency and result in lower emissions per unit of milk or meat produced. The goal is to reduce 2.2 million metric tons of carbon equivalent of methane emissions by the year 2000. Specific plans include improved grazing management, strategic dietary supplementation, the use of production-enhancing technologies, improved animal health, improved genetics, and reproduction.	Mark Orlic, Office of Atmospheric Programs 1-202-564-9043 Orlic.Mark@epa.gov www.epa.gov/rlep
9. Voluntary Aluminum Industrial Partnership (VAIP)	Primary aluminum producers	Part of the Climate Change Action Plan and USEPA's Partners for the Environment. VAIP is an environmental stewardship and pollution prevention program to encourage reduction of PFC gas emissions from aluminum production. The goal is to reduce PFC emissions from U.S. aluminum production 45 percent by 2000—roughly 2.2 million metric tons of carbon equivalent.	Eric Jay Dolin, Climate Protection Division 1-202-564-9044 Dolin.Eric@epa.gov www.epa.gov/vaip
10. SF6 Emissions Reduction Partnership for Electric Power	Electric utilities and electricity providers who use SF6-filled	This voluntary partnership encourages electric power systems to reduce the emissions of sulfur hexafluoride (SF6) from electrical equipment, for example, circuit breakers. SF6 is an extremely potent greenhouse gas. Emissions reduction action partners improve the operation and maintenance of equipment, recycle SF6, and retire older, leakier equipment.	Eric Jay Dolin, Climate Protection Division 1-202-564-9044 Dolin.Eric@epa.gov

Program	Sector	Description	Contact Info
Systems	equipment	USEPA launched this program at the end of 1998 and is recruiting partners.	
11. SF6 Emission Reduction Partnership for the Magnesium Industry	Magnesium producers and magnesium casting companies	One of USEPA's newest voluntary industrial partnerships, this collaborative program is intended to reduce SF6 emissions from magnesium industrial processes, where technically feasible and cost-effective. Partner companies and USEPA will evaluate and implement cost-effective emission reduction technologies and strategies.	Scott Bartos, Climate Protection Division 1-202-564-9167 Bartos.Scott@epa.gov
12. PFC Emission Reduction Partnership for the Semiconductor Industry	Semiconductor manufacturers	Part of the Climate Change Action Plan. This is a partnership between USEPA and twenty-four U.S. semiconductor manufacturers to reduce emission of perfluorocompounds (PFCs). The partners are now implementing reduction technologies following a pollution prevention hierarchy that includes *(a)* process optimizations, *(b)* alternative chemistries, *(c)* recovery of PFCs from the exhaust stream for reuse, and *(d)* destruction of the chemicals before release to the atmosphere. The U.S. partnership led the global industry to seek reductions of these potent greenhouse gases through participation in the World Semiconductor Council.	Scott Bartos Climate Protection Division 1-202-564-9167 Bartos.Scott@epa.gov
13. Common Sense Initiative	Automotive manufacturing	(See the Common Sense Initiative under Office of Reinvention for description and web site.)	Keith Mason, Office of Policy Analysis and Review 1-202-260-1360 Mason.Keith@epa.gov
Office of Enforcement and Compliance Assistance			
14. Compliance Assistance	Automotive service, metal	Provides small businesses in specific industries with tools that assist them with regulatory compliance. This includes helping facilities iden-	Andy Teplitzky Office of Compliance

Program	Sector	Description	Contact Info
Centers	finishing, printing, agriculture, printed wiring board, local government, transportation, small to medium chemical companies, paint and coating	tify particular federal environmental regulations that apply to their specific line of business, taking appropriate steps to improve compliance with environmental regulations, and considering pollution prevention approaches. Each "virtual" center focuses on a particular industry and is operated in partnership with the private sector, academic institutions, environmental groups, and other federal and state agencies.	1-202-564-5082 Teplitzky.Andy@epa.gov es.epa.gov/oeca/mfcac.html
15. Sector Facility Indexing Project (SFIP)	Petroleum refining, iron and steel, metal refining and smelting, pulp manufacturing, automobile assembly	A pilot project that examines and compares records of individual facilities and assists businesses and corporations in tracking their own environmental performance. It is a useful planning and analytical tool for government and currently contains records for five industry sectors that consist of approximately 640 facilities. SFIP presents inspection, compliance, and enforcement data that focus on the Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act. SFIP also includes information on the location and production capacity of each facility, as well as the population of surrounding areas.	Robert Lischinsky Office of Compliance 1-202-564-2628 Lischinsky.Robert@epa.gov http://es.epa.gov/oeca/sfi
16. Self Audit and Inspection Guide	Metal finishing industry	USEPA and the National Defense Center for Environmental Excellence have developed a CD-ROM–based program, "A Self-Audit and Inspection Guide for Facilities Conducting Cleaning, Preparation, and Organic Coating of Metal Parts." The guide is a unique compliance assistance	Anthony Raia Office of Compliance 1-202-564-6045 Raia.Anthony@epa.gov

Program	Sector	Description	Contact Info
		tool that utilizes video and animation to provide regulatory and technical information. The CD-ROM places the user at a virtual control panel, from which they can navigate a tour through a paint and coating facility. The guide provides a narrated description of seventeen metal parts cleaning, coating, and curing processes with Internet hot links to additional resources. It also provides summaries of applicable Federal environmental statutes, regulatory requirements, and pollution prevention alternatives.	
17. Industry Sector Notebook Project	Thirty major industry sectors	The Sector Notebook Project provides an overview of individual sectors as well as cross-cutting environmental issues. Thirty notebooks have been completed, and each contains general background information, national distribution of facilities, process descriptions, waste releases, pollution prevention opportunities, applicable statutes and regulations, compliance and enforcement history, pollution prevention opportunities, and a contact directory. The notebooks are supposed to direct decision-makers toward more "holistic" solutions to environmental problems.	Seth Heminway Office of Compliance 1-202-564-7017 Heminway.Seth@epa.gov www.epa.gov/oeca/sector
18. Common Sense Initiative	Printing	(See the Common Sense Initiative under Office of Reinvention for description and web site.)	Gina Bushong Office of Compliance 1-202-564-2242 Bushong.Gina@epa.gov
Office of Policy			
19. Sustainable Industry Project	Metal finishing,	Part of USEPA's Partners for the Environment. The Sustainable Industry Project provides incentives and removes barriers to better environmental	Bob Benson, Office of Policy Development

Program	Sector	Description	Contact Info
	chemical manufacturing, food processing, metal casting, travel and tourism, and photo processing	performance in selected industry sectors. Each industry sector presents a different set of corporate traits, trends, and decisionmaking factors—drivers and barriers—that influence corporate environmental performance. By understanding those sector-specific factors, USEPA can tailor its policies and programs to promote strategic environmental protection effectively.	1-202-260-8668 Benson.Robert@epa.gov www.epa.gov/sustainableindustry
20. Common Sense Initiative Metal-Finishing Sector Strategic Goals Program (SGP)	Metal finishing industry	The Strategic Goals Program, designed and endorsed by the CSI multistakeholder group, establishes a set of voluntary national performance goals that represent "better than compliance" environmental performance. These targets will improve resource utilization, reduce hazardous emissions, improve economic paybacks, and reduce unnecessary compliance costs. The program includes industry commitment to continuous environmental improvement and industrywide goals for full compliance, enforcement of chronic noncompliers, and "brownfields prevention." Participating facilities are working to achieve these goals by 2002.	Bob Benson, Office of Policy Development 1-202-260-8668 Benson.Robert@epa.gov www.strategicgoals.org
21. Transportation Partners	Local government and transportation sector	Part of the Climate Change Action Plan and USEPA's Partners for the Environment. The program develops innovative, nonregulatory approaches to reduce carbon dioxide emissions from the transportation sector. The program also reduces the growth of vehicle miles traveled through various measures that provide a greater variety of transportation choices for citizens. The program helps the community design economic or market-based incentives, and advanced technologies that enhance	Allen Greenberg, Office of Policy Development 1-202-260-0626 Greenberg.Allen@epa.gov www.epa.gov/tp

Program	Sector	Description	Contact Info
		mobility and create sustainable communities.	
Office of Prevention, Pesticides, and Toxic Materials			
22. Design for Environment	Printing, electronics, metal finishing, dry cleaning, industrial laundries, and auto refinishing	Part of USEPA's Partners for the Environment. The Design for the Environment program was created to promote the incorporation of environmental considerations into the design and redesign of products, processes, and technical and management systems. The program encourages pollution prevention and efficient risk reduction in a wide variety of activities. Under Design for Environment, USEPA works through voluntary partnerships with industry, professional organizations, state and local governments, federal agencies, and the public, including environmental and community groups.	Marla Hendriksson, Office of Pollution Prevention and Toxics 1-202-260-8301 Hendriksson.Marla@epa.gov www.epa.gov/dfe
23. Green Chemistry Challenge	Chemical manufacturers and users	Promotes the development of products and processes that reduce or eliminate toxic substances associated with the design, manufacture, and use of chemicals.	Tracy Williamson, Office of Pollution Prevention and Toxics 1-202-260-3960 Williamson.Tracy@epa.gov www.epa.gov/greenchemistry
24. Common Sense Initiative	Computer and Electronics	(See the Common Sense Initiative under the Office of Reinvention for description and web site.)	John Bowser, Office of Pollution Prevention and Toxics 1-202-260-1771 Bowser.John@epa.gov

Program	Sector	Description	Contact Info
Office of Solid Waste and Emergency Response			
25. Wastewise	More than fifty sectors including local governments, hospitals, aerospace, communication, printing and publishing	Part of the Climate Change Action Plan and USEPA's Partners for the Environment. This partnership program seeks to conserve energy and natural resources and prevent pollution by reducing municipal solid waste, such as corrugated containers, office paper, yard trimmings, packaging, and wood pallets. Partners sign on to the program for a 3-year period to reduce municipal solid waste by preventing waste, collecting recyclables, and increasing the manufacture and purchase of recycled products.	Jeff Tumarkin 1-703-308-8686 Tumarkin.Jeff@epa.gov www.epa.gov/wastewise
26. Common Sense Initiative	Petroleum refining	(See the Common Sense Initiative under Office of Reinvention for description and web site.)	Steve Souders, Office of Emergency and Remedial Response/ Superfund/Oil/Programs 1-703-308-8431 Souders.Steve@epa.gov
Office of Water			
27. Water Alliance for Voluntary Efficiency (WAVE)	Lodging industry, office buildings, schools, and colleges and universities	Part of USEPA's Partners for the Environment. WAVE seeks to reduce water consumption, while increasing efficiency, profitability, and competitiveness through the installation of water-efficient equipment; link water-use efficiency to reduced operating costs; enhance members' image; and educate their staff, employees, and customers about the benefits of water efficiency.	John Flowers, Office of Water 1-202-260-7288 Flowers.John@epa.gov http://www.epa.gov/owmitnet/wave_01.htm

Program	Sector	Description	Contact Info
28. Common Sense Initiative	Iron and steel	(See Common Sense Initiative under the Office of Reinvention for description and web site.)	Judy Hecht, Office of Water 1-202-260-5682 Hecht.Judy @epa.gov
Office of Reinvention			
29. Common Sense Initiative (CSI)	Automobiles, computers, and electronics, iron and steel, metal finishing, petroleum refining, and printing	CSI developed "cleaner, cheaper, and smarter" approaches to environmental protection through an industry-based, multistakeholder consensus process. CSI had two roles—addressing challenges common to CSI sectors and ensuring the successful attainment of CSI goals through the sectors. More than forty CSI projects in more than a dozen states included regulatory development, permitting, record keeping and reporting, compliance and enforcement, pollution prevention, environmental technology, and community involvement. CSI operated as a Federal Advisory Committee in 1994–98.	Kathleen Bailey, Office of Reinvention Programs 1-202-260-3413 Bailey.Kathleen@epa.gov www.epa.gov/commonsense
30. Project XL	Facility-based industry projects	Part of USEPA's Partners for the Environment. Project XL provides regulated entities an opportunity to develop models for a new, performance-based environmental management system for the next century—one that emphasizes better bottom-line results for protecting public health and the environment. The goal is for fifty projects to be proposed or under implementation by end of 1999.	Chris Knopes, Office of Reinvention Programs 1-202-260-9298 Knopes.Christopher@epa.gov http://www.epa.gov/ProjectXL
Office of Research and Development			
31. Technology for a Sustainable	Chemical manufacturers,	The TSE Grant Program addresses the technological and environmental issues of design, synthesis, processing, production, and use of products	Barbara Karn, National Center for Environ-

Program	Sector	Description	Contact Info
Environment (TSE)	sectors that benefit from environmentally conscious design and manufacturing	in manufacturing industries. The TSE program advances the development and utilization of innovative technologies that avoid or minimize the use or generation of hazardous substances. Eligible applicants include academic and nonprofit institutions in the United States and state or local governments.	mental Research and Quality Assurance 1-202-564-6824 Karn.Barbara@epa.gov http://www.epa.gov/ncerqa
32. Common Sense Initiative	Metal-finishing sector	(See the Common Sense Initiative under the Office of Reinvention for description and web site.)	Paul Shapiro, National Center for Environmental Research and Quality Assurance 1-202-564-6833 Shapiro.Paul@epa.gov

APPENDIX D:

SELECTED CHEMICALS USED IN THE ELECTRONICS SECTOR[86]

Twenty-Seven Chemicals Used in Semiconductor Manufacturing	
Antimony compounds	Nickel compounds
Arsenic compounds	Phosphine
Arsine	Phosphorous
Carbon tetrachloride	1,1,1-Trichloroethane
Catechol	Trichloroethylene
Chlorine	Xylene
Chromium compounds	Nitrogen trifluoride *
Ethyl acrylate	Perfluoroethane *
Ethyl benzene	Perfluoromethane *
Ethylene glycol	Perfluoropropane *
Hydrochloric acid	Octafluorobutane *
Hydrofluoric acid	Sulfur hexafluoride *
Methanol	Tetrafluoromethane *
Methyl isobutyl ketone	

Thirteen Chemicals Used in Semiconductor Packaging	
Chlorine	Lead compounds
Chromium	Methanol
Ethyl benzene	Methylene chloride
Ethylene glycol	Nickel compounds
Hydrochloric acid	Toluene
Hydrofluoric acid	1,1,1 Trichloroethane
	Xylene

Eleven Chemicals Used in PCB/PWB Manufacturing	
Chlorine	Ethylene glycol
Dimethylformamide	Lead compounds
Formaldehyde	Methylene chloride
Hydrochloric acid	Nickel compounds
Hydrofluoric acid	Perchloroethylene
	1,1,1-Trichloroethane

[86] Chemicals marked with an asterisk are nonregulated—but potent—greenhouse gases used in semiconductor manufacturing. All others are regulated chemicals identified by the U.S. Clean Air Act. USEPA (1995b).

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